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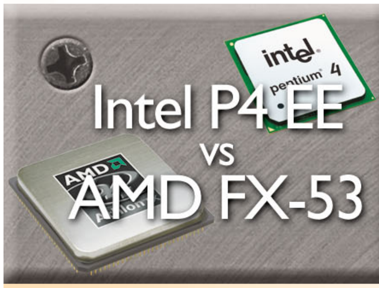

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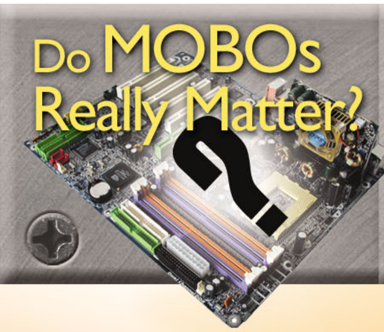

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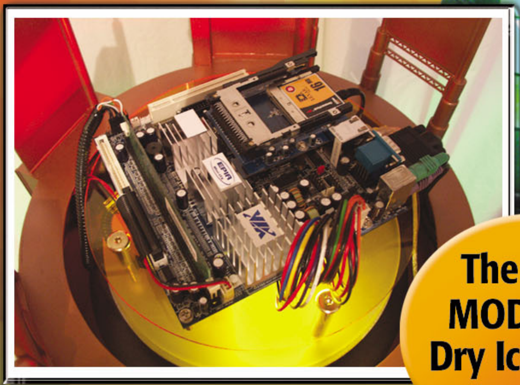

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PC Modder

CPU COMPUTER POWER USER Special Issue V1.1

Chips and chipsets. They're the heart of any computing system, and as usual, we have packed this issue of *PC Modder* with dozens of possible processor and motherboard matchups. Our Case Studies will help you discover what sort of performance you can expect to achieve when overclocking various chip and chipset combos. When you're ready to crank up your own silicon, our Cool It articles will provide tips on keeping excess heat under control. And then when it's time to build the ultimate home for your motherboard, our Cut It section will give you some case ideas to drool over. Whether you're a modding novice or master, you'll find this issue is filled with all the tips and tools you need to build faster and more beautiful PCs.

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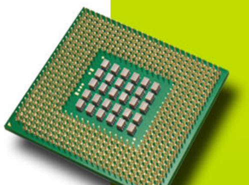

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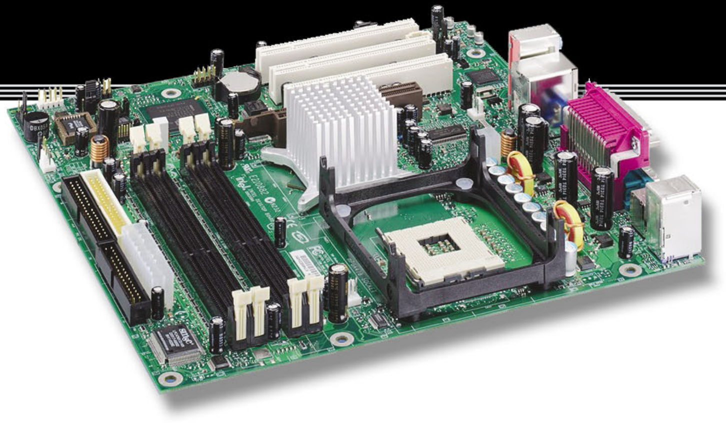

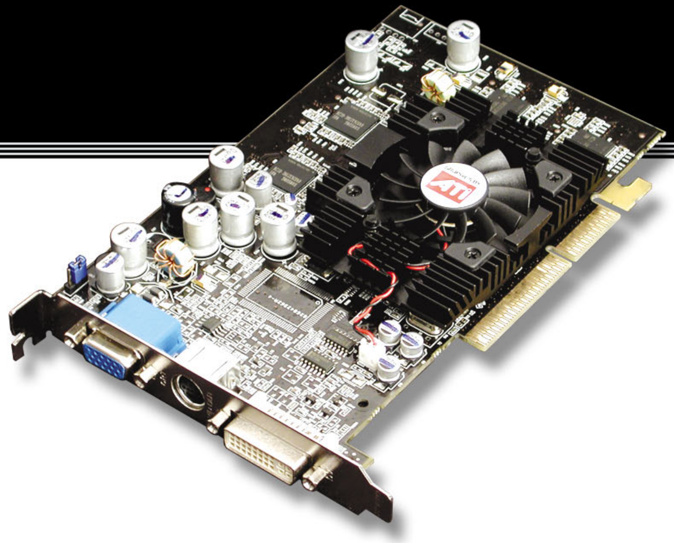

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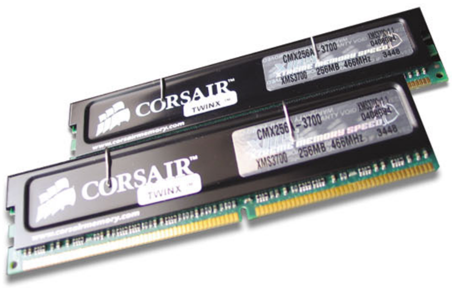

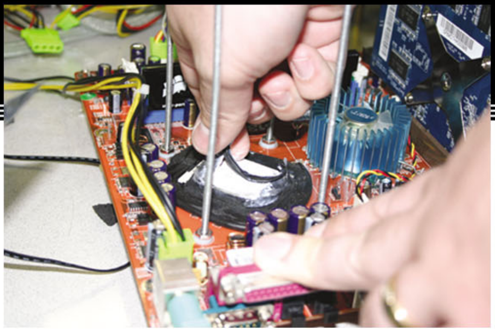

PC Modder

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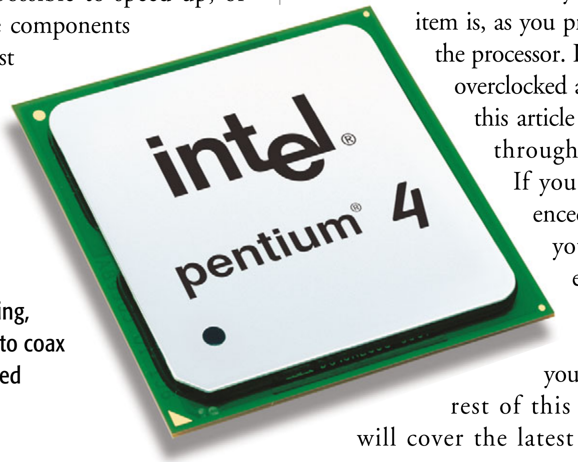
THE NEED FOR SPEED

Take Your CPU To Ultimate Heights One Step At A Time

Overclocking, or power modding as it is also known, is a goal of many advanced computer users. Overclocking a system lets it run faster than it would at the supported speeds of its components. For instance, you could overclock a 2.4GHz processor to run at 3.2GHz. A successful overclock will help games run smoother, processor-intensive tasks run faster, and overall performance improve. However, there is a reason power modders are so proud of their overclocked systems. Overclocking is really quite an art form, requiring patience, experimentation, knowledge, and just a bit of luck. For this reason, many people overclock systems simply for their own enjoyment and the thrill of squeezing the highest performance out of any given component.

The reason you can overclock hardware is because most components have a range of speeds at which they will work. Manufacturers set component speed ratings within the range at which they know the parts will function as advertised. But it's often possible to speed up, or overclock, some components to the uppermost levels of their ranges and still have them operate. Of course, it's also possible to overclock too much, which can cause erratic performance or even make a component fail. Not all processors, even of the same model number and speed, will overclock to the same level. That's why overclocking usually voids manufacturer warranties.

You can overclock several components, including the processor, system memory, and even some video cards. The most commonly overclocked item is, as you probably know, the processor. If you've never overclocked a CPU before, this article will walk you through the process. If you're an experienced overclocker, you can consider this article a brief review before you dive into the rest of this issue, which will cover the latest and greatest components, overclocking experiments and results, extreme cooling systems, case mods, and other fascinating reads for the power user.



This processor may be rated at 2.4GHz, but with careful overclocking, you may be able to coax a faster clock speed from it.

Before You Start

If you built your computer yourself, you already have an advantage when it comes to overclocking. Systems built from the ground up are usually easier to overclock than proprietary, prebuilt computers. In fact, some manufacturer-assembled computers come with many of the BIOS settings locked. If this is the case, you may not be able to change the FSB (frontside bus), a setting that is the key to overclocking a modern system.

If you build your own PC, you have other advantages, as well. For instance, you can do your own research and choose parts that have a reputation for being highly overclockable. You can also be careful to avoid any components that use especially new or groundbreaking technology. The longer a manufacturer has produced a particular component or used a specific manufacturing process, the more likely it is that the process has been refined and that the hardware will remain stable when overclocked.

When you build your own system, you can also choose a motherboard that is well-suited to overclocking. Intel's motherboards are generally not a good option for overclocking because they do not provide much freedom to tweak settings in the BIOS. On the other hand, many motherboard manufacturers intentionally build their boards to allow very liberal tweaking of settings such as the FSB and core voltage. When we tested the very new and very fast PC4400 DDR SDRAM in "My DDR Can Beat Up Your DDR" on page 124, we

Some motherboards have more overclocking features than others. This board by Asus provides more overclocking freedom than most.

had to use either an Asus P4C800 Deluxe or Asus P4C800-E Deluxe motherboard. That's because those were the only two boards that provided the overclocking freedom necessary to tweak the FSB and run and benchmark such new and fast memory at the proper frequency.

There are other reasons the choice of motherboard is important. As one example, many motherboards have built-in sensor chips that monitor temperatures and voltages. This can help you ensure that conditions in your PC are as safe as possible for all of your hardware, even after you've overclocked a component. In addition, many motherboards come with software that helps overclockers monitor critical data that is collected from the sensor chips. This includes temperatures, core voltages, and fan operation. For more information about overclocking utilities, see "Essential Overclocking Utilities" on page 25 and the accompanying "Motherboards With Great Utility" chart bundled with motherboards on page 28.

Before you overclock your CPU, it is important to research your processor. The more you read about overclocking with your processor, the more you will know what some realistic overclocking goals might be. You can read past issues of *PC Modder* and *CPU*, scan overclocking forums, and read overclocking Web sites to see what results others have had and what you might expect from your processor. Others' results will not, however, tell you exactly how far you can push your CPU. Even processors manufactured from the same wafer vary slightly. In addition, your other system components will likely differ from those of other overclockers. For a variety of reasons, you may get a lower or higher overclock than others. Others' results will serve as a guide for your own attempts at overclocking.

Learning about others' results is essential, even if your experiences differ from those of others. Knowing what is possible and what is common can help you start with a reasonable overclock. Then, if your computer is stable, you can gradually attempt to push the system further.

In order to overclock, you need to have a basic understanding of the mathematics of overclocking. There is one basic equation that drives the changes you will make in the BIOS. This equation is made up of the processor's effective clock speed, the FSB, and the CPU's multiplier. There are other factors, such as the voltage and temperature, which we will discuss later.

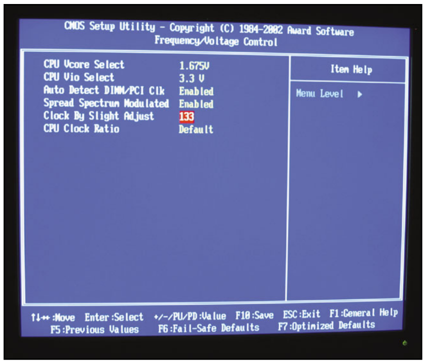
The basic equation for overclocking is: **multiplier x FSB = clock speed.**

AMD's relatively new Athlon 64 FX-53 CPU has a clock speed of 2.4GHz, or 2,400MHz. It also has an effective system bus of 400MHz. Because the Athlon 64 FX's bus is quad-pumped, the FSB is actually 100MHz, or 400MHz divided by four. If you insert 2,400MHz and 100MHz into the above equation, you will see that the Athlon FX-53's multiplier is 24 (the 2,400MHz clock speed divided by the 100MHz FSB).

In order to overclock the processor (increase its clock speed), you need to alter either the multiplier or the FSB. The multiplier is locked on most modern processors, so in order to change the clock speed of the CPU, you need to tweak the system bus, the only part of the equation you can change. You will do this a little bit at a time, increasing the FSB in small increments and testing the system after each overclock to ensure that it is still stable (able to POST, launch Windows, and run dependably). If the system is still stable after an overclock, you can try to push its clock speed a little bit further.

Because overclocking involves changing settings in the BIOS, it is a good idea to make sure you have the most recent version of the BIOS installed. Check the motherboard manufacturer's Web site for BIOS updates before you proceed.

Also, if you plan to overclock a system that stores any important data, please back up your system before you begin. Overclocking can be risky business, so be prepared in case the worst happens. If you have an older computer that you don't use anymore, you may want to practice overclocking it before you tweak your primary computer system. You may also need to use a cooling method other than the stock fan that came with your CPU (or preinstalled in your PC). There are several



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                      Frequency/Voltage Control

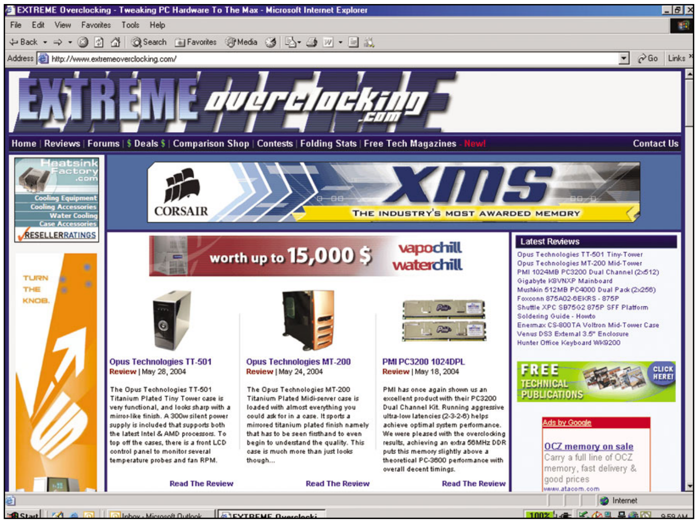
  CPU Vcore Select              1.675V              Item Help
  CPU Vio Select                3.3 V
  Auto Detect DIMM/PCI Clk      Enabled         Menu Level  ▶
  Spread Spectrum Modulated     Enabled
  Clock By Slight Adjust        133
  CPU Clock Ratio               Default

 ↑↓→← :Move  Enter:Select  +/-/PU/PD:Value  F10:Save  ESC:Exit  F1:General Help
    F5:Previous Values    F6:Fail-Safe Defaults    F7:Optimized Defaults
```

The BIOS may look slightly different on your system, but the basic procedure is the same. Gradually increase the FSB setting.

articles about cooling in the Cool It section of this issue, beginning with "Heatsink Heaven" on page 132.

Finally, one last word before you get started. Overclocking is not an activity that manufacturers officially support. Although several new motherboards, processors, and memory modules are promoted as highly overclockable, pushing hardware beyond its official specs usually voids the warranty. Not only may overclocking damage the component you are trying to overclock, but it may also damage other system components. Because overclocking voids warranties, you should be prepared to swallow the cost if your system sustains any damage during a fateful overclock.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Enermax CS-800TA Voltron Mid-Tower Case
Venus DS3 External 3.5" Enclosure
Hunter Office Keyboard WK9200

Opus Technologies TT-501
Review | May 28, 2004

The Opus Technologies TT-501 Titanium Plated Tiny Tower case is very functional, and looks sharp with a mirror-like finish. A 300w silent power supply is included that supports both the latest Intel & AMD processors. To top off the cases, there is a front LCD control panel to monitor several temperature probes and fan RPM.

Read The Review

Opus Technologies MT-200
Review | May 24, 2004

The Opus Technologies MT-200 Titanium Plated Midi-server case is loaded with almost everything you could ask for in a case. It sports a mirrored titanium plated finish namely that has to be seen firsthand to even begin to understand the quality. This case is much more than just looks though...

Read The Review

PMI PC3200 1024DPL
Review | May 18, 2004

PMI has once again shown us an excellent product with their PC3200 Dual Channel Kit. Running aggressive ultra-low latencies (2-3-2-6) helps achieve optimal system performance. We were pleased with the overclocking results, achieving an extra 56MHz DDR puts this memory slightly above a theoretical PC-3600 performance with overall decent timings.

Read The Review

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There are many places where you can find out what results others have had overclocking a given processor.

Overclocking 101

To get started overclocking, you should enter the BIOS before Windows loads. The BIOS menus vary, depending on the motherboard you use. Find the section of the BIOS menu that contains settings for the frequency and voltage, which will contain the FSB settings. After you have entered the proper section of the BIOS, change the FSB to the desired speed. For example, if you bump the FSB up from 100MHz to 133MHz, you will increase the effective system bus to 533MHz and the clock speed to approximately 3.2GHz, or the 133MHz FSB x the multiplier of 24 (3,192MHz or 3.2GHz).

As you increase the FSB, you need to keep the installed RAM in mind. It is rated for a certain frequency. That frequency is determined by the FSB, so you need to be careful not to push the FSB beyond the point your memory can handle. When you do this, you overclock the memory, which is certainly something you can do, but it is easiest to first run the memory within its specifications. This way, if the system is unstable after you increase the FSB, you know if the problem is with overclocking the processor or with overclocking the memory. Once the system is stable with the CPU overclocked, then you could think about overclocking the memory.

An example can demonstrate the importance of considering memory when adjusting the FSB. PC3200 DDR SDRAM, also known as DDR400, is rated at 400MHz. Memory runs at the same frequency as the FSB, but because DDR is dual-pumped, the 400MHz frequency actually correlates to a 200MHz FSB (200MHz x 2 = 400MHz effective). When you alter the FSB of a system with PC3200 DDR, you would not want to push the FSB higher than 200MHz if you want the memory to stay within its spec.

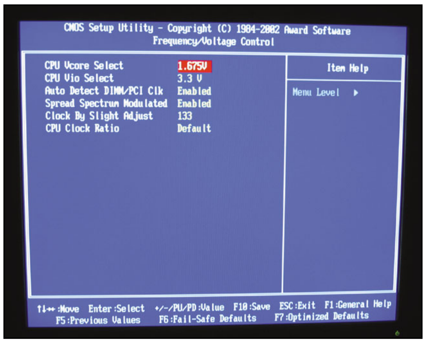
After you adjust and save the FSB setting, exit the BIOS. When the computer reboots, check the screen when the system POSTs to see what the listed clock speed is. It should indicate the new, overclocked speed. If not, return to the BIOS and try to adjust the settings. If you can choose a lower FSB, that may make the system more stable. You can also increase the voltage because an overclocked system generally requires more voltage than a system running at the officially supported speed.

Once you get your system to POST at the overclocked speed, the next challenge is getting Windows to run. If the system is highly unstable, Windows will probably not load. If you can successfully start Windows, you know that the overclocked system is relatively stable, but you should still tax the CPU to ensure that if the system is not stable, you know it before you begin using your PC for important tasks.

There are many programs you can use to test the stability of a system. Many of these utilities are covered in "Essential Overclocking Utilities" on page 25. A free program that places a decent amount of processing weight on the CPU is Prime95, a program developed for GIMPS (Great Internet Mersenne Prime Search). This project lets users download the Prime95 client, which takes advantage of unused CPU capacity to run equations, searching for prime numbers. Often, monetary prizes are available to those who discover new prime numbers.

Although you may not choose to take part in the race to find new primes, you can still use Prime95. Its equations will stress your processor as it works equations and compares them against known primes. If the computer does not find the correct numbers, the system is not stable at the overclocked speed.

If your stability-testing utility indicates that the system is not stable, you need to make an adjustment to the BIOS settings, either lowering the FSB or increasing the voltage. Remember that in order to overclock just one component at a time, you should ensure that the FSB remains within the spec for the



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CMOS Setup Utility - Copyright (C) 1984-2002 Award Software
Frequency/Voltage Control

CPU Vcore Select              1.675V
CPU Vio Select                3.3 V
Auto Detect DIMM/PCI Clk      Enabled
Spread Spectrum Modulated     Enabled
Clock By Slight Adjust        133
CPU Clock Ratio               Default

↑↓→← :Move  Enter:Select  +/-/PU/PD:Value  F10:Save  ESC:Exit  F1:General Help
  F5:Previous Values   F6:Fail-Safe Defaults   F7:Optimized Defaults
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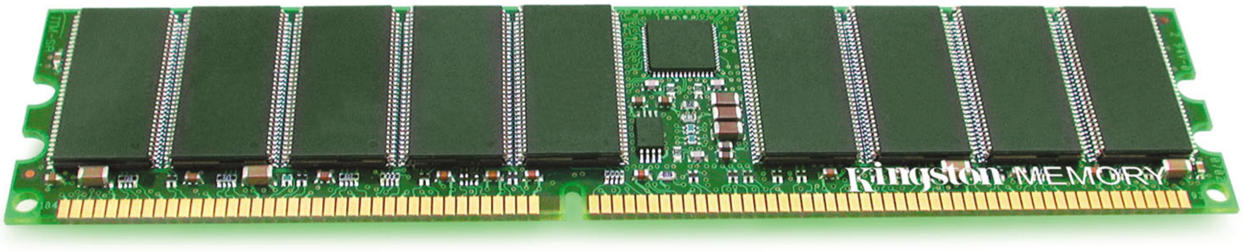
If the system is unstable after an overclock, you may need to increase the voltage in the BIOS.



Keep system RAM in mind when overclocking. If you stay within the specs for the memory as you overclock the processor, it is simpler to troubleshoot stability problems.

RAM. If you exceed the designated frequency for the RAM, when the system becomes unstable, you won't know if the problem is the overclocked processor or the overclocked memory.

You should let Prime95 (or any stability-testing utility) run for at least a couple of hours. If you let Prime95 run for at least six hours without errors, you can say with a relative degree of certainty that your overclocked system is fairly stable and able to handle heavy loads on the processor. If you can devote an even greater period of time to running the stability check, however, you will increase the certainty with which you can say that your overclocked system is stable.

As you increase the voltage to stabilize the system, you may find that the CPU overheats. At the very least, high processor temps will make a system unstable. At the worst, overheating may damage components. This is one of the reasons overclocking is a perform-at-your-own-risk activity. You can reduce the odds of damaging equipment, however, by monitoring system temperatures as you tweak your PC. Try installing a temperature-monitoring utility, such as Motherboard Monitor (Freeware; mbm.livewiredev.com) or Hmonitor ($29 for a one- or two-user personal license; www.hmonitor.com). You can read more about these and other utilities in "Essential Overclocking Utilities" on page 25.

If the temperature gets too hot, you will need to make adjustments to avoid damage. Acceptable temperatures vary depending upon the type of processor you use. AMD Athlon XP processors have an Ordering Part Number label. The third character on the label indicates the maximum temperature. An S-rated processor can safely heat to 95 degrees Celsius, a T-rated processor has a maximum temperature of 90 C, and a V-rated processor can be heated to only 85 C.

The maximum temperature for other processors is not so straightforward. In general, the processor case of Athlon 64s should not heat beyond 70 C. Intel's maximum temperature ratings are much lower, with a 38 C limit on 478-pin Pentium 4s above 2.8GHz and a 40 C limit for other P4s. Both of those suggested maximum temperatures are for the processor case rather than the processor itself. If you use Intel's Active Monitor utility (included with Intel motherboards) to monitor system temperatures, you should not let the temperature of the CPU core rise above 64 C. You can find this and other information about suggested CPU temperatures in the "Pushing The Limit" sidebar in "Keep Your Cool" on page 156.

If the temperature nears the maximum limit, you should either reduce the FSB or consider trying a better cooling method. As mentioned earlier, the articles in the Cool It section of this issue, which begins on page 132, discuss a variety of cooling methods and equipment, including third-party heatsinks, thermal compounds, heat spreaders, case fans, blowholes, peltier systems, watercooling, and phase-change systems. You may wish to incorporate one of these cooling methods into your system to provide more wiggle room for increasing the voltage.

To achieve the highest overclock possible, continue to gradually increase the FSB, in very small steps, until the system becomes unstable and you can no longer safely increase the voltage without running into temperature problems with your chosen cooling method. When the system hits this unstable point, gradually lower the FSB setting until the system is once again stable. Remember to run a utility that will stress the system to ensure that it is truly stable at the final overclocked speed.

Once you have tested a system and confirmed its stability, you may want to run a benchmark or two to see how well the overclocked system runs. SiSoftware's Sandra ($34.99 for single-client license; www.sisoftware.co.uk) is one application you can run to gauge your system's performance. Another popular benchmarking program is Futuremark's PCMark 04 Pro ($29.95 personal-use license; www.futuremark.com). If you download PCMark 04 Pro, you can save $10. Both of these programs will run a variety of benchmarks on your system and provide an objective account of the PC's performance.

Overclocked & Built For Speed

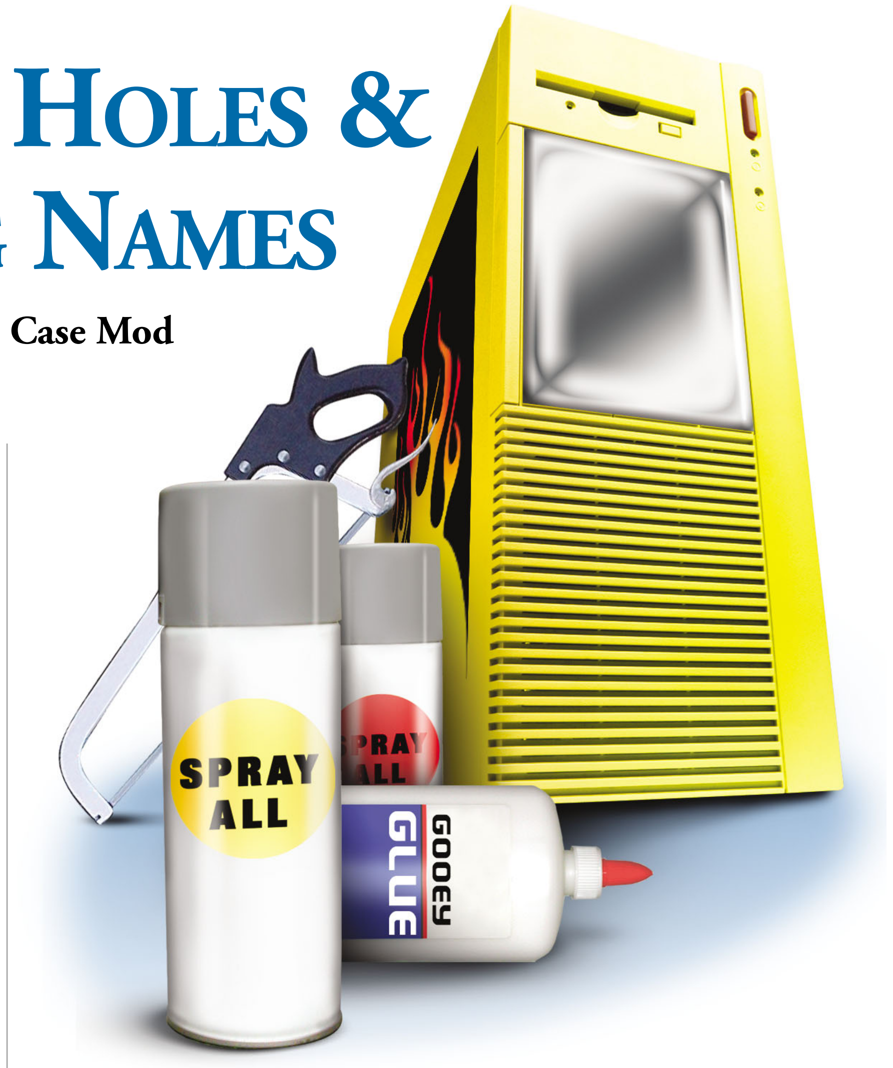
As you can see, overclocking a processor is a very gradual process. It requires not only patience but also a healthy balance of conservatism and risk taking. By carefully tweaking the FSB, monitoring temperatures, and providing the necessary cooling to your system, you can sometimes see quite dramatic leaps in performance and speed.

After your system is overclocked and running stable, you can enjoy the speed benefits of your new, faster PC. Perhaps more importantly, you now have bragging rights to a system that you conquered and pushed to the ultimate speeds. The rest of this issue will provide a handy reference for your newfound thirst for speed and CPU power. CPU

by Kylee Dickey

CUTTING HOLES & TAKING NAMES

Your First Case Mod



If you're the sort of power user who feels the constant need to pick up a power tool and modify anything and everything, this article is not for you. If, on the other hand, you're considering your first case mod, such as adding a blowhole or window to your case, or if you just want to paint your beige beast a more inviting color, we can help.

Why should you cut your own window and/or blowholes? For one thing, it's cheaper than buying a premodded case, provided you have the proper tools on hand, not to mention the pride you'll feel when you look at your newly modded case, knowing you did all the work yourself. This step-by-step article will walk you through the basics of dressing up your case (sometimes called vanity modding), and we'll also point out a few of the pitfalls as we go.

We began preparing for this vanity modding primer by seeking out a reasonably priced case made of steel, which is a ferrous metal, meaning that it contains iron. (Note that aluminum is a softer, nonferrous metal and is, therefore, easier to cut, but an aluminum case often costs more. It's not a bad idea to save a few bucks on your first attempt just in case things don't go to plan.) We purchased a Chiefmax (www.chiefmax.com) 769-PL1 Beige Mid Tower ATX for $30.00, which included a 450-watt power supply. Note that our case came with textured side panels, which you'll want to avoid. But we'll discuss that further in a moment.

In the interest of simplicity, we chose to buy a window installation kit for our case. Window kits are readily available online in a variety of shapes and colors, some of which include custom etched Plexiglas. The kit we used cost $15 and included a clear, square precut Plexiglas window, a strip of rubber molding, a locking strip, a standard washer, and installation instructions.

We used a Dremel MultiPro variable-speed rotary tool to cut a hole in the side panel for our window and a variable-speed drill equipped with a hole saw for cutting the blowhole in the Chiefmax's top panel.

Window To The Soul

Performance purists may ask why anybody would want to look at the static interior of a PC, but the multitude of lighting accessories, ultraviolet reactive components, and colored PCBs (printed circuit boards) on the market is proof that people like to see what's inside. There are practical benefits, too. A case window makes it possible for users to find out with a glance whether a heatsink fan has stopped working or determine exactly which component is smoking as a result of a botched overclocking session.

Preparation. We started by removing all of the panels from the case's chassis. We made sure to prep the side panel that would give us the best view of our components, not the one that would reveal the backside of our system's motherboard. We placed the chosen side panel face up on a flat surface and covered it with masking tape, which protected the surface from scratches and also gave us a good marking surface.

Next, we laid the Plexiglas window on the panel where we wanted to install it. It's a good idea to make sure your window is at least an inch from the edge on all sides. We placed our window closer to the back and bottom of the panel to minimize the view of the system's drive bays and power supply unit. We also made sure to position our window hole so that we weren't cutting through overlapping pieces of metal.

We then put the washer against the edge of our Plexiglas and used a pencil inside the washer to trace the window. This left a .25-inch border around the window, which is for fitting the window molding. We used the resulting outline as a guide for cutting our window hole.

Cutting. Because we used a Dremel tool, there was no need to start with a pilot hole, but if you plan to use a jigsaw, you'll need to drill a hole on the inside edge of the traced outline to start your cut. We used emery wheels on our Dremel, specially designed for cutting through metals such as steel. Before cutting make sure you are in a well-ventilated room or outdoors and are well away from flammable materials. When cutting metal with a variable-speed rotary tool, it's also a good idea to check the tool's manual for recommended cutting wheel speeds. Our Dremel has a 35,000rpm maximum speed, and the manual suggested we use the full speed for cutting steel. Make sure you take appropriate safety measures when using power tools, such as wearing protective eyewear.

Any last words, plain Jane?

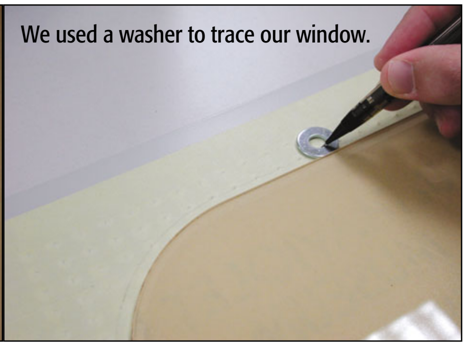
We started on a straight edge to get a feel for how the tool cut before moving on to a curved edge. If you use a Dremel, sparks will fly, so cut away from your body. As we cut along the window outline, the emery wheel wore down; we used three wheels to finish our window. For thicker steel or a larger window, you may end up using more. We replaced the cutting wheels when they wore down to two-thirds of their original size. When cutting rounded edges, we began with small cuts, lifted the Dremel, angled the tool, and cut again. This makes for a jagged corner, but the window molding will mask your handiwork, and at this stage cutting accurately is far more important than getting a smooth, straight cut.

When our window hole was complete, we filed the sharp edges with a deburring accessory included in our Dremel set. You can also use a hand file to remove excess metal and smooth jagged edges. Next, we removed the masking tape from the panel.

Plexiglass and molding. We made sure we were working on a clean surface, free of metal shavings that might scratch the Plexiglas. The window molding is smooth and rounded on one side and grooved on the other side. We started with the panel's interior side facing up and fit the narrow edge of the molding onto the window opening so the locking groove was visible. Then we fit the molding all the way around the inside of our window hole. The molding strip was too long, so we cut the strip to the proper length using a utility knife.

We used Scotch tape to hold the molding in place, removing it piece by piece as we installed the Plexiglas. When fitting the Plexiglas into your molding strip, start with a corner and pull the edge of the molding lip over the edge of the window. At the halfway point, you'll need something you can fit between the molding and the Plexiglas to shoehorn the window in place. We used the flat wrench included in the Dremel set. Fitting the Plexiglas into the molding can be tedious and difficult, so be patient and work slowly to keep the window from slipping out. With the window in place, we installed the locking strip, which fits into the groove on the inside of the panel. We inserted the pointed side of the locking strip (which clamps the molding onto the Plexiglas to keep it snug) down and worked our way around the molding until our panel was finished and ready to show off our computer's guts.

Using a kit makes installing a window a snap.



We used a washer to trace our window.

A Breath Of Fresh Air

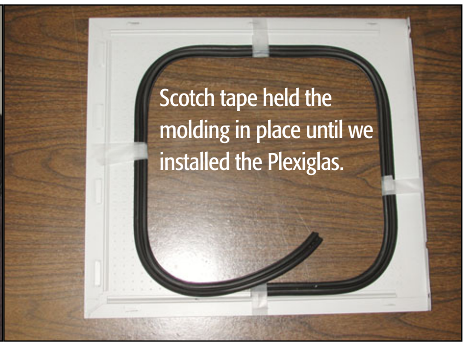
Blowholes can significantly improve air circulation within your computer's case. Although no amount of air circulation will cool your processor and components below the ambient air temperature, this is often sufficient to ameliorate temperature spikes that result from moderate overclocking. Also, if done properly, a blowhole (with the help of an LED-adorned fan and an attractive fan grille) can add to your system's visual appeal.

Preparation. You can use a jigsaw, rotary tool, or drill fitted with an arbor and hole saw to cut a blowhole. We chose to use a drill and hole saw because it offers the cleanest cut. Unlike a window hole that is covered with molding, the edges of a blowhole will be visible when you're done, and most fan grilles won't adequately mask a jagged hole. Typically you'll want a 3.125-inch (76mm) hole saw for an 80mm fan, which is the size of most standard case fans. We decided to go all the way and install a massive 120mm fan, so we used a 4.75-inch (121mm) hole saw, which is nearly the diameter of a CD.

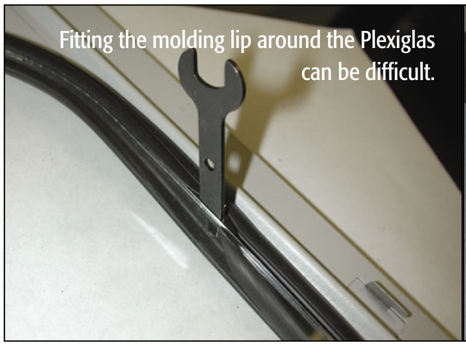
We had to prep our case for cutting before our fan arrived, so we had to measure and cut the hole without the benefit of having the fan to use in drawing an outline. We chose to install the blowhole in the top of our case. We started by marking the top panel to represent the interior location of our power supply unit and our optical drive. This gave us about six inches of leeway for installing our fan where it would do the most good. We covered the section we planned to cut with masking tape, found the center of the panel, and drew a straight line on all four sides using a ruler. Next, we positioned the 4.75-inch hole saw over the center point and traced it. You will need to divot the center point with an awl or nail punch to keep the drill in place while cutting.

Bear in mind that if you're at all interested in upgrading your fan in the future, it's best to initially cut a smaller hole and use a larger hole saw later. If you decide to install a smaller fan, you can use a fan adapter, but note that adapters will increase the profile of the fan.

The Dremel does its job with flair.


Scotch tape held the molding in place until we installed the Plexiglas.

Cutting. We suggest using a corded drill for steady, continuous power, but a cordless drill can provide a similar experience as long as you start with a fully charged battery. Again, make sure you take the proper safety precautions, including wearing goggles and working in an open or well-ventilated space. With our panel clamped down over an open space, we started our cut by positioning the drill tip in the divoted center point. It's best to use the highest speed your drill can provide, and be sure your drill is set to turn in the proper direction. While drilling, we applied enough pressure to keep the hole saw in constant contact with the metal, but not so much that the drill bogged down. Typically top panels are thicker than side panels, so it may take some time to cut through. When the hole was drilled, we used the Dremel with a deburring accessory to file down its sharp edge.


Fitting the molding lip around the Plexiglas can be difficult.

We used a short nail to divot the center point for our blowhole.

Place your fan over the hole on top of the masked panel. Center it, mark the screw holes with a pencil, and drill the holes using a standard drill bit no wider than the screw holes of the fan. When we were finished, we removed the masking tape and installed the fan according to the supplied instructions. Keep in mind that you want your case to take in more air than it blows out by a 2:1 ratio.

Color Your World

Painting your case is one of the most fundamental ways to improve the look of your system. Artistic ability is not as important as attention to detail and a good color scheme. We chose to paint our case panels charcoal and the chassis blaze orange. (Note that if you're combining any cutting projects with a paint job, it's best to paint last so as not to chip or mar your paint job when cutting or drilling window holes or blowholes.)

Shopping list. We used spray paint for our case because it's relatively cheap and easy to work with. We bought two cans of Rust-Oleum brand fast-drying, wet-sandable primer. It's a good idea to get either white or pale gray primer, which will help your colored paint to more closely resemble the color you'd expect based on the cap. We also got cans of Rust-Oleum textured charcoal, Painter's Touch blaze orange, and Painter's Touch multipurpose flat clearcoat. We bought some low-grit sandpaper, but if you want a smooth finish, you should use 600-grit wet/dry sandpaper.

Preparation. When painting, you'll want to find a work area with plenty of ventilation that's clear of the elements. You may also want to put down plenty of plastic sheeting or cardboard to keep overspray from marking up your work area. We removed all the case panels from the chassis of our PC and took special care to remove the LEDs and Power and Reset buttons from the face panel. Our case has a built-in USB hub in the front, so we removed it along with the plastic feet on the underside of the chassis. We also popped out each of the drive bay covers to paint them separately. We arranged everything on our painting surface (cardboard) so that we had enough room to paint all sides of each panel when laid flat on the ground. If your case has textured paint or textured plastic panels, you might want to sand them first. It isn't necessary to strip off the original coat of paint, but sanding will help the paint adhere and give you a smooth surface to start with. Make sure each panel is clean and dry before you begin.

Painting and sanding. We started by using the primer on everything, holding the can 6 to 12 inches away from the surface. We used an even, back-and-forth motion and never sprayed the same spot for too long. You don't need to paint the inside of your case panels, but make sure you cover every side that will be visible when your case is reassembled. Because the chassis is bare metal, the primer helps prevent the paint from dripping. It is best to apply several light coats of the primer rather than one heavy coat. If the coverage looks uneven after your first coat, don't worry, wait for it to dry and apply another coat. Each coat of primer took roughly 30 minutes to dry, but once we applied a few coats, we waited 24 hours to let it cure. You might consider using string to suspend the chassis from the ceiling of your work area to get to all sides in a single session.

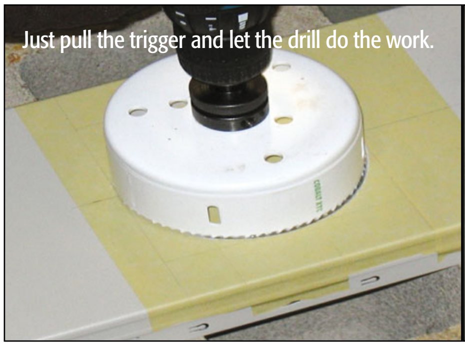
Once the primer has cured, you can sand it smooth, taking special care not to sand down to the original paint. As we mentioned earlier, you should avoid using a case with textured panels, as these can make adequate sanding nearly impossible. For a smooth finish, keep the sanding surface wet throughout the sanding process to prevent scratching. Because we wanted a textured surface, we chose to dry sand our panels. We applied another coat of primer to get as even a finish as possible, waited 24 hours, and sanded again. Finally, we were ready to apply the colored paint.

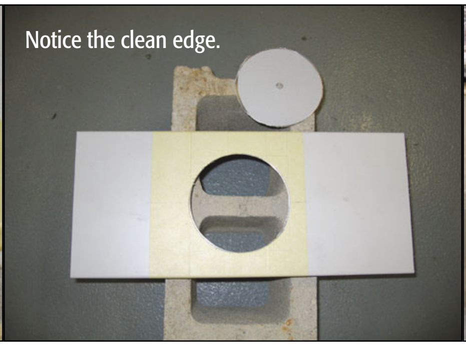
If you plan to paint any panels multiple colors, use masking tape to cover the parts of the panel you want to keep free of paint. If masking large sections of a panel, use masking tape at the edge and newspaper to cover the panel, rather than masking the entire surface, which can damage a previously applied coat. We painted the chassis with the Painter's Touch blaze orange. You'll want to paint different-colored panels or components well away from other parts because paint dust and overspray can alter your intended finish. We found this out the hard way, as our gray panels came out with a mildly perceptible orange tint. After several coats and another 24-hour curing period, our panels and chassis were finished. We applied the clearcoat finish to the outer panels to serve as a protective barrier. Once the clearcoat was dry, we reinstalled the window and put our case back together.

Worth The Effort

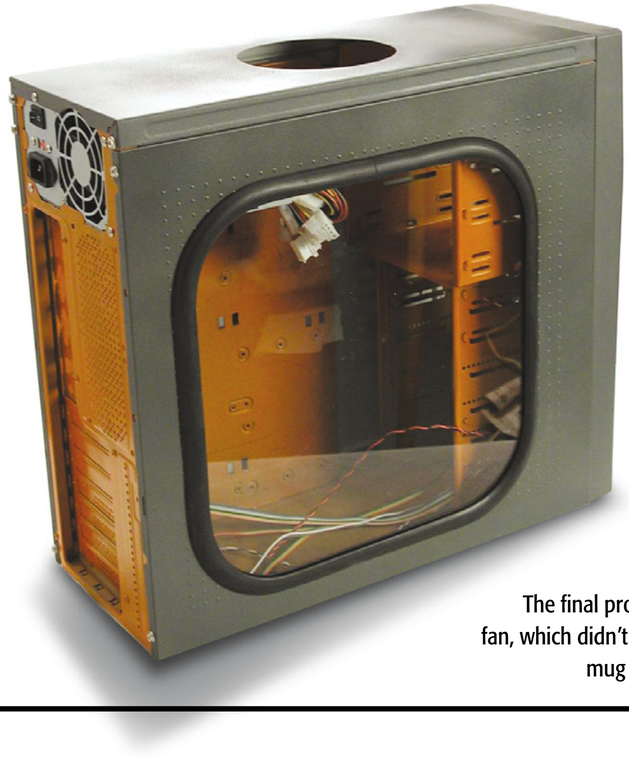
Vanity modding tends to be a longer, more drawn-out process than performance modding, which offers instant gratification, assuming everything works when you turn on the power. Cosmetic mods take patience, and if you only have one computer, it can mean being without a PC for days. But if you have the patience to see your project through, you can take pride in the fact that you have created something unique.

by Andrew Leibman


Just pull the trigger and let the drill do the work.

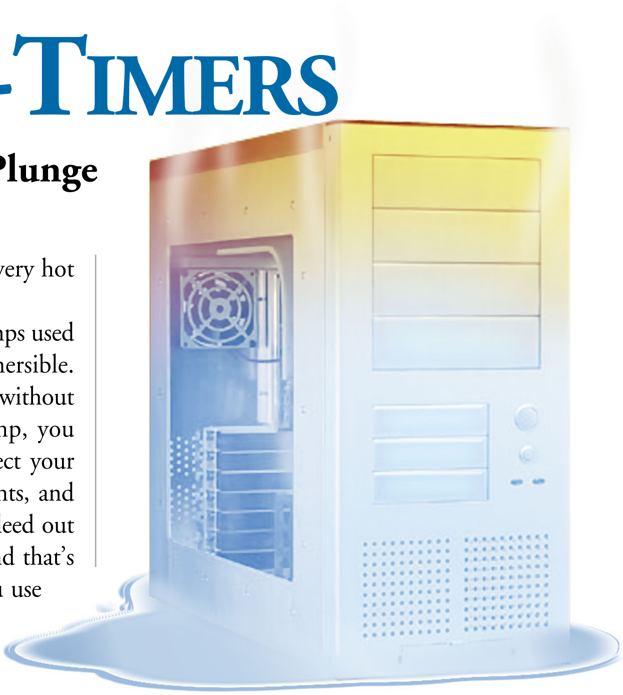

Notice the clean edge.

We stood the panels up for more even coverage.


The final product (minus the fan, which didn't arrive in time to mug for the camera).

WATER FOR FIRST-TIMERS

Tips To Help Watercooling Newbies Take The Plunge



Watercooling systems no longer make up just a trickle in the PC market—they're a mainstream cooling concept, and users who ignore the potential of water's chilling properties risk getting one-upped by the competition. Don't fret if you've avoided wading into the water until now. There are so many excellent watercooling products available that you can easily add H20-based components and have your computer back up and running in an hour or less.

PC enthusiasts unfamiliar with watercooling technologies will want to be aware of standard caveats when working with their new wet toys. We'll preempt a lot of your questions with step-by-step instructions on installing a new watercooling kit and offer plenty of other water-related tips along the way.

Component Basics

There are so many variations in watercooling components that it's easy to be overwhelmed by your choices. We'll start by breaking things down into simplest terms. Every watercooling system has three fundamental parts, including a pump, waterblock, and a fan/radiator combo, all of which are connected via flexible and (hopefully) watertight tubing. Many systems also include a separate water reservoir to increase fluid capacity.

For the system to be effective, water must move from part to part in a certain order. Water flows from the pump and into the radiator, which drops the water's temperature, to the waterblock, which transfers heat from the CPU to the cooler water, which moves back to the water pump again.

Pumps. Make sure you use high-quality parts in your watercooling system. Using a flimsy-looking water pump can come back to haunt you, as cheap pumps might spring leaks, or just as bad, stop working—and water that's not moving through the radiator will become very hot and eventually help fry your CPU.

There are two basic types of pumps used for watercooling: inline and submersible. Inline pumps can be used with or without a reservoir. To use an inline pump, you pour water into the system, connect your tubes to the appropriate components, and fire up the pump. You'll have to bleed out any air in the system, of course, and that's somewhat difficult to do when you use an inline pump and no water reservoir.

As their name implies, submersible pumps must be submerged in water before they will work properly. Most manufacturers include a reservoir for submerging this type of pump. Unlike inline pumps, it's much easier to avoid air trapped in the cooling loop when you use a submersible pump.

Radiator/fan. Radiators are blocks of metal with many flattened tubes (typically made of copper) arranged in a parallel pattern. As with water pump reservoirs, radiators have both an inlet and outlet; water warmed by the CPU comes through the inlet and moves through the fins of the radiator. Those fins conduct heat to the fan-blown air moving through the radiator's slits.

Manufacturers give their radiators either a BTU (British Thermal Units) or KCal (calories burned by heat) per hour rating. The higher the rating, the more heat a radiator can disperse to the surrounding air. If you have serious cooling needs, you can buy a dual-fan radiator, which is twice the size of a regular radiator and provides extra cooling capability. Other radiators are passive, meaning that they substitute noisy fans with a giant heatsink.

Waterblock. Waterblocks have the all-important task of transferring heat from the CPU to circulating water. To perform this job effectively, a waterblock must cover the entire CPU and be made of a material that conducts heat quickly. Many waterblocks use copper, aluminum, or silver, all of which have good heat transference characteristics.

And don't forget. There are other watercooling components that require your consideration. Tubing, in particular, can greatly hinder or help your project depending on its characteristics. Very flexible tubing is great for winding through the maze of parts and crevasses in your case, but that same quality also means it kinks easily. Rigid tubing resists kinks but is hard to manipulate through tight quarters, and even if you succeed in snaking the tube into the right spot, it might place undue pressure on the waterblock and CPU.

Water is another component that you shouldn't overlook. Using water straight from the tap is a sure way to deposit harmful minerals throughout your system. Tap water may also cause oxidation to ruin the metal components in your cooling loop, and for that reason alone, distilled water is the only way to go. Also, to prevent icky algae build-up, your water needs an anti-algae additive, which you can find on your favorite components site.

Now we'll show you how we installed a basic kit. Hardcore users scoff at kits, calling them overpriced, underperforming monstrosities with so-so parts and middling performance. Though kits are more expensive than selecting and assembling individual components yourself (see our "Water By Design" sidebar), you're supposedly assured that every part fits the way it should, a not-so-insignificant trait when you're undertaking a potentially patience-testing task for the first time.

Basic Kit Steps

We bought a basic—but expensive—preassembled component kit from FrozenCPU (www.frozencpu.com) so we could show you the fundamentals of a watercooling system installation. Assembling a kit sounds like an elementary task, but it really wasn't as easy as expected.

Our generic $200 kit included all the necessaries, such as tubing, an inline aquarium water pump, a water reservoir designed to fit in a 5.25-inch drive bay, radiator and 80mm fan, hose clamps, waterblock, an assortment of screws, springs, nuts, and washers, but, ahem, no assembly instructions. Guess we picked the right kit for this story, huh?

There are two ways to go about installing a watercooling system. Many enthusiasts assemble their systems outside their PC case and let the pump run for several hours to make sure every component is free of leaks. Users with more confidence (and healthy publishing company equipment budgets) throw caution to the wind and build the cooling loop on and around expensive equipment. If you opt to assemble your kit outside the case, you'll simply have to be a little more careful when you cut your lengths of tubing to make sure everything fits the way you want it to.

1. The first step in assembling a kit is to check out the parts at your disposal and plan a course of action. There's nothing worse than diving into a system project and then finding out 40 minutes later that you misplaced or misused a critical screw or clamp. Make sure you have an idea of where each part goes, and make sure you have the right number of nuts, bolts, clamps, and other vital hardware.
2. Affix the waterblock to your motherboard. You'll likely have to remove your motherboard from its case to complete this task, so disconnect cables, uninstall the CPU heatsink and fan, take out your mobo's screws, and lift the board carefully from the case.

Water By Design

If you like DIY projects and don't want to be a target for the elitist sneers of watercooling purists, forsake kits, pick and choose your own cooling components, and assemble a one-of-a-kind system that will make your friends as green as the pond scum growing on their waterblocks. Going forward without a kit means a couple of things. One, you'll have to wing it as you go and improvise when necessary. Two, without prefitted parts you run a greater risk of leaks and other critical problems. These are both worthy challenges that you'll be proud to overcome.

Before you can begin, you will have to order the parts you want to use, including tubing, a waterblock, radiator and fan, a pump, and the hardware to make everything watertight. Pick your products carefully to make sure components fit properly.

Waterblocks are crucial in every watercooling system, and they come in many different flavors. You can buy ultra-basic aluminum blocks, expensive all-copper blocks, a block that combines both aluminum and copper, and aluminum blocks dipped in a silver coating. You'll find that radiators offer similar diversity. Beware, though, of mixing aluminum and copper components in your cooling system, as this will cause rust to occur much faster than normal. If you must mix metals in your cooling loop, be sure to add a good dose of rust-inhibitor additive, but be aware that this dependency on chemicals will probably let you down in the end.

Most systems use 1/4-inch, 1/2-inch, or 3/8-inch connection points, and as you buy parts, make sure all your components have connectors of the same diameter; otherwise, you'll end up cutting, splicing, and generally making your loop weaker. It also makes the building process more complex because you need more fittings.

Trying to connect and disconnect tubing is a pain in the neck. You can make this task easier by using quick-disconnect fittings that have female and male connectors with a button that makes it easy to pull tubing free. If you opt for traditional barbed fittings, you will need the appropriate hose clamps, which have several variations, including flimsy wire clamps that apply very little pressure to the hose and barb. We prefer plastic clamps that let you squeeze the hose until it screams.

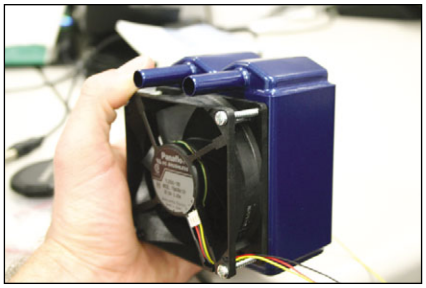
You already know that you can use either a submersible or inline pump for your system, and there are significant differences between the two. Submersible pumps are housed in a reservoir, a little quieter than inline pumps, and have a setup that makes it easier to evacuate air bubbles. Inline pumps can be use with or without a reservoir. Reservoir-less pumps tend to be louder and make it very difficult to bleed out every air bubble; that's a potentially deadly problem because if an air bubble lodges itself in the waterblock, your CPU might suffer heat exhaustion.

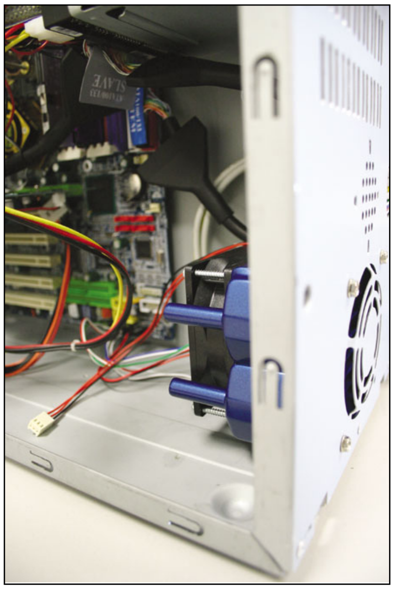
As your peruse pump options, keep your eyes on the GPH (gallons per hour) and lift ratings. A pump that moves 100GPH is plenty for general watercooling purposes, and lift, which refers to the height that a pump can move water, should be at least 20 inches or so, letting you efficiently push water to all corners of your case.

With a little practice and some smart shopping, you can put together an amazing cooling system unlike any other for far less than the price of a kit. Just be sure to follow standard safety precautions and take your time putting things together to avoid component-killing leaks. ▲

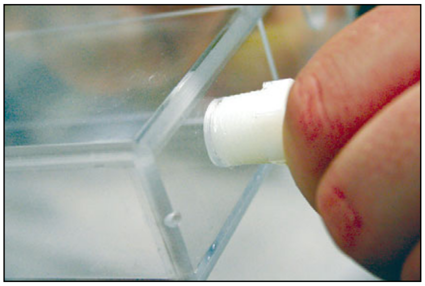
3. Apply a thin layer of thermal grease to the top of the CPU. Use the end of a plastic card (you don't really need that credit card, anyway) to evenly spread the grease.
4. Slide the long screws through the motherboard and secure a washer and nut to the backside of the mobo. This will keep the screws in place as you affix your array of hardware on top of the motherboard.
5. This bag of hardware really isn't as confusing to use as it first seems. You've already used four washers and four nuts to keep the long screws from sliding out of the motherboard. Now you just need to finish the topside hardware configuration. Slide the plastic washers into place and secure them with a nut. Slip a spring and then a washer onto each screw and then lower the waterblock into place.

6. Now drop a washer on each screw, and then use the four gold nuts to tighten the entire assembly. Cross-thread the nuts to make sure you apply pressure evenly, and when the waterblock is snug, make sure it covers the entire surface of the CPU.
7. Reinstall the motherboard, reattach all cables and wiring, and use ties to keep cables neat and out of the way of your forthcoming cooling system components.
8. The radiator and reservoir are the two biggest parts in this kit, so install these first. In our situation, the space-hungry graphics card forced us to mount our radiator to a fan outlet at the front of the case—our hoses would have had very little clearance at the case's rear. We used two long screws to secure the fan to the radiator, and the radiator to the case, making sure the fan oriented to blow through the radiator and out of the case.



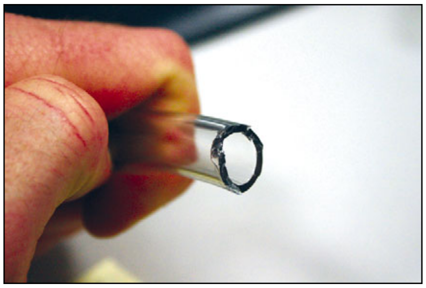


9. Many reservoirs are large and hard to place in a cramped case, but this water tank mounts neatly into a 5.25-inch drive bay. No problem, right? Unfortunately, the hose connectors that shipped with the reservoir didn't fit the reservoir's inlet/outlet holes. We tried inserting the connectors at every angle with no luck, and brute force only threatened to damage the reservoir. Pressing deadlines force us to improvise. We used a cigarette lighter to soften the threads on our connectors, which we then forced a couple of millimeters into the reservoir.



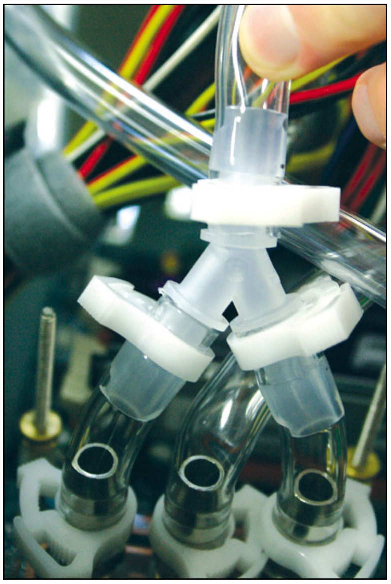
10. We applied waterproof sealant to the leaky cracks around the connectors. We used copious amounts of the sealant and squished it into the cracks to make absolutely sure there would be no route for water to escape, and then we let the sealant cure for 24 hours. Don't cut corners on the curing process unless you're not worried about water dripping all over your expensive circuitry. Once the glue dries, test the reservoir's seals outside the case, and when you're sure there are no leaks, insert the reservoir into a drive bay, preferably a bay below your pricey DVD drives. Secure the reservoir with screws.

11. Take the length of tubing and practice routing it from component to component inside your case. You don't have a lot of extra tubing to work with, so don't do any cutting until you have a good idea of how long each section needs to be. You will probably catch the hose trying to kink at tight turns, and you can usually prevent kinking by adding or subtracting a little of the tube's length. The two sections that attach to the reservoir should be on the long side. This extra length will let you slide the reservoir from the drive bay when it's time to add water.
12. Cut a single length of tubing. We recommend starting with the longest piece

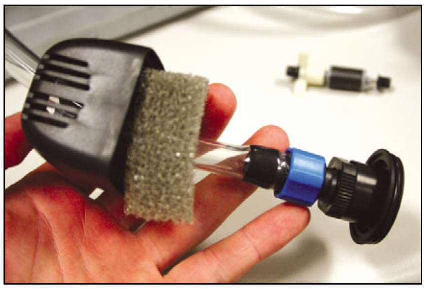


first. Use a sharp tool so you end up with a clean cut that rests snugly against each component. Slip a hose clamp over one end of your tubing, lubricate the hose and component barb with a little saliva, and push the hose all the way onto the barb. Wiggle the hose clamp into place and use pliers to squeeze it tight. Repeat this procedure for each connection point.

13. Because this waterblock has three barbs, including a center inlet and outlets on either side, you have to use a Y-connector to bring the outlet hoses together. Cut the outlet tubes short, but long enough to give them some flexibility for the Y-connector and also so you can bend the outlet tubes slightly towards the reservoir. Remember that the plastic Y-connector isn't as tough as, say, the metal barb connectors on the waterblock or radiator, so make sure you don't put undue pressure on this component by using hoses that are too short. Don't forget to use hose clamps here, as well.



14. We partially disassembled our pump so that we could slide the tubing onto the barb; it took a lot of effort to push the tubing into place and we didn't want to apply unnecessary force to the pump's innards. If you have to disassemble your pump for any reason, be absolutely sure that you put it back together completely; otherwise, you risk catastrophic leaks. We initially forgot to replace the plastic twist-lock for this pump, and water went everywhere—fortunately, we were testing the pump outside the case, so no damage occurred.



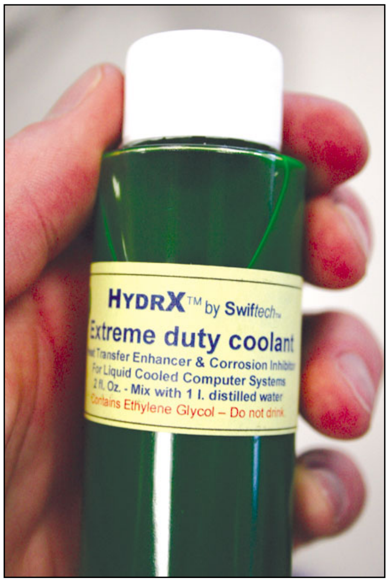
15. Double-check your circuit of tubing to make sure each connection is secured with a hose clamp. Verify that there are no kinks in your hoses. Position the water pump outside the case for your initial water testing. After you have all your connections made, it may be tempting to perform a dry run before filling your system with water, but that's a bad idea. That waterblock is made to work optimally with water, not air, so if you attempt to boot up, you'll likely encounter heat-related problems, such as aborted startups or error messages.

16. Unplug your PC's power cable. Remove any super-precious components, such as that $400 graphics card, the $200 RAM modules, or the hard drive. If you are extremely paranoid about encountering leaks on your system's first run, you can test the setup outside the case, but where's the fun in that?

17. Slide the reservoir out a few inches and unscrew the cap. This particular reservoir has a rather small fill hole, and it's a good idea to use a funnel to keep water from running all over the place. If you don't have a plastic funnel, just curl a couple of sheets of copier paper to form a temporary water guidance tool. Pour in a few cups of your distilled water and keep an eye open for leaks, and then set down the water jug and tilt your PC's case back and forth to make the water work its way through the various connection points. Once everything looks watertight, go ahead and pour in more water, and keep tilting the reservoir to let the fluid settle toward the water pump.

18. Once the tubing near the pump is full, plug in the pump and let it run for a second. Pour in more water and run the pump again. Repeat this procedure until your hoses are free of air bubbles.

19. Top off the reservoir with the green coolant. Don't forget this step, as coolant prevents rust and algae from developing on your components, lowers water temperatures a bit, and also makes your hoses glow green under a blacklight. Wicked. Turn off your computer room's overhead light and start overclocking, Mad Modder style.


HYDRX™ by Swiftech
Extreme duty coolant
Heat Transfer Enhancer & Corrosion Inhibitor
For Liquid Cooled Computer Systems
2 fl. Oz. - Mix with 1 l. distilled water
Contains Ethylene Glycol – Do not drink

System Maintenance

Every six months or so, it's a good idea to flush your system with distilled water and refill it with fresh water and a new dollop of coolant. Examine each component to make sure there are no visible signs of corrosion, mineral buildup, or organic growth. Then reassemble the system, and you'll be ready for another stretch of overclocking. CPU

by Nathan Chandler

BENCHMARK BASICS

A Primer On Measuring Your PC's Performance

"Man, I raced some loudmouth kid last night," your tuner friend tells you. "All that J.C. Whitney wannabe saw were my six taillights."

"How fast were you going?" you ask. "What was your time to the next stoplight?"

"Uh, I forgot to look," your friend hedges. "But it was awesome."

PC modders have just as much need for speed as the local gearhead. But you have to admit that it makes for a much better story if you can show how much speed your rig has on tap. Sure, your new 3D card may feel faster, but how much swifter is it, really? Is overclocking your CPU's frontside bus worth it? Will more RAM actually help the games and apps you use?

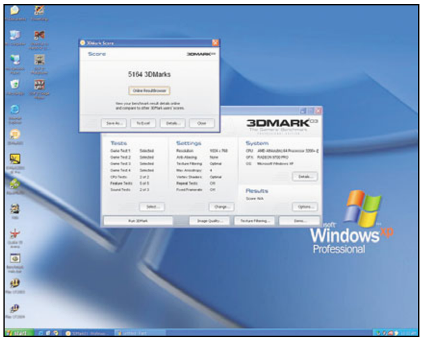
Benchmarking, or using software to pin down your computer's speed to a score of some kind, may sound a little dry at first. But the first time you realize that you just gave yourself a 9% faster graphics card with a quick—and free—overclock, benchmarking will get into your blood. You'll not only be doing before-and-after tests to try out new devices and tweaks, you'll be comparing your system's scores with your buddies before long.

Benchmark Brothers

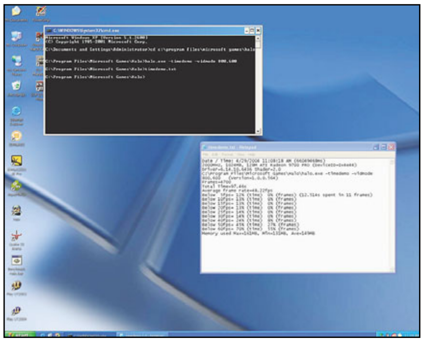
There are two basic types of benchmarks. Synthetic ones are standardized tests or suites of tests. Real-world benchmarks are measurements of how fast an actual application, game, or device can run on your PC. Many benchmark utilities have free, limited versions, so try before you buy.

Synthetic. SiSoftware Sandra Professional 2004 (SP1) ($34.99; www.sisoftware.net) is a well-known synthetic benchmark suite for various PC attributes. Sandra offers scores of granular device and bus tests, as well as instant comparisons to other devices and PCs.

Futuremark's PCMark 04 Pro ($14.95; www.futuremark.com), meanwhile, analyzes the speed of typical home user demands. These include antivirus, audio and video, encryption, and compression duties. Futuremark also distributes a number of other benchmarks made by BAPCo, such as MobileMark for notebooks, WebMark for Internet transaction speeds, and SYSmark. SYSmark ($399.95) is a basically more expensive counterpart to PCMark04 that measures business workloads.



Most synthetic benchmarks, such as 3DMark03, rate your system's speed as a score of accumulated points.

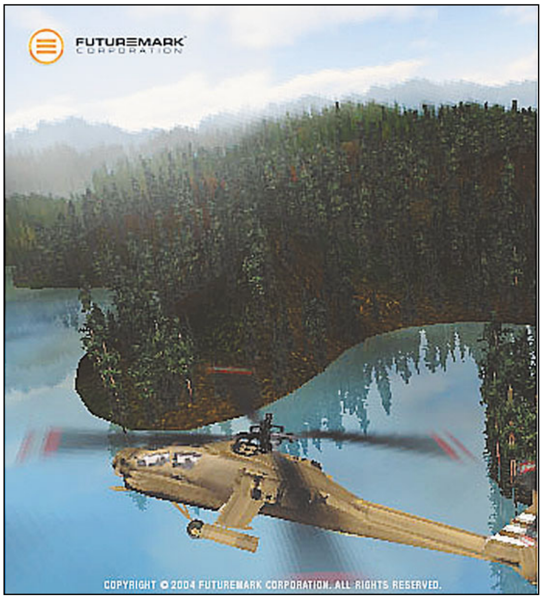


Halo, like many other games, can rate your graphics card's fps rate during a standard demo. This is considered a more real-world test than a synthetic benchmark.

AquaMark3 ($9.95 and up; www.aquamark3.com), SPECviewperf 7.1.1 ($50; www.spec.org), and 3DMark03 Pro ($19.95; www.futuremark.com) are video card benchmarks. SPECviewperf measures a card's performance with the OpenGL API, while AquaMark3 and 3DMark03 gauge cards using Microsoft DirectX 9.0 and earlier. Most games are programmed to use DirectX rather than Open GL, so AquaMark3 and 3DMark03 are of more interest to gamers.

Finally, there are benchmarks made specifically for testing hardware, such as Nero's Nero CD-DVD Speed V2.20 for CD and DVD drives (www.cdspeed2000.com) and HD Tach 2.7 for hard drives (www.simplisoftware.com). Sandra can also test such drives. These benchmarks generally tell you how fast a drive can read and/or write data in a vacuum; that is, without demands from multiple processes or users. For a more realistic look at how a new drive will affect your system's overall performance, use PCMark04 or a similar app-based suite.

Real-world testing. A more direct way to benchmark apps and devices is to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Futuremark's new smartphone benchmark, shown here in an exclusive photo, can test phones such as the Motorola A925; Nokia N-Gage, 7650, and 3650/3600; Panasonic X700; Siemens SX1; and Sony Ericsson P900.

time how long it takes them to do common tasks. For instance, you might use a normal stopwatch to time an Adobe Photoshop batch process or how long it takes an MPEG-4 encoding utility to process a particular video clip. You can also hand-time file transfers to and from your hard drive, as well as the length of time it takes your burner to make a DVD or CD.

Meanwhile, games often have mechanisms that tell you how many fps (frames per second) they can render, often during standard demos that are included with the game.

Both synthetic and real-world benchmarks have their uses, so run at least one of each for a more complete picture of your PC's prowess. "These two types of benchmarks definitely complement each other, and we never advise any of our clients to depend on only one benchmark," Sarkkinen says.

Ready, Set, Mark

Now that you know what the types of benchmarks are, it should be easier for you to decide on which to use. The main question is what part of your system you're trying to improve through overclocking or swapping parts.

For overall productivity with office apps or media file transcoding, you'd benchmark with PCMark04, Sandra, and your individual apps. If you're more interested in gameplay or CAD, though, you'd test with 3DMark03, your apps, and/or your games.

Before you benchmark for scores that you plan to compare with others', prep your PC to run its best. Stop all other programs, including antivirus, firewall, and Windows' System Restore. Set your card to the resolution, color depth (a measure of the number of colors that can be displayed simultaneously, such as 32 bit), and feature settings that your competitors use. Finally, be sure that your benchmark has the latest patch from the developer's Web site and that your motherboard, video card, and other devices are using the latest drivers. Futuremark lists drivers approved for use with its benchmarks at www.futuremark.com/community/drivers/?approved.

On the other hand, for your own personal frame-rate tuning, you might want to keep your real-world FPS testing in the real world. In other words, if you play games online over a broadband connection, test your video card with your antivirus utility and firewall running, too. There's no point in finding your system's optimal frame rate for a particular game's settings if the fps are going to plunge when you turn on other essential apps.

3DMark03. You can start 3DMark03's default tests by clicking Run 3DMark. The program will run several interesting scenarios that look like they've popped out of video games. 3DMark03 will time your card to see how fast it can render the scenes, as well as gauging its aptitude for various graphics features, such as Shader model 2.0.

To customize 3DMark03, click Change, Image Quality, or Texture Filtering. You'll be able to adjust resolution, shader settings,

Cheater, Cheater

The big "cheating" controversy last year has admittedly been well-documented elsewhere, but we have to at least mention it here. Basically, Futuremark discovered that certain Nvidia drivers seemed to be optimized for better 3DMark03 scores. In other words, a card with an Nvidia GPU might outpace a comparable ATI-based adapter in 3DMark03, but wouldn't prove to be any faster in real-world apps and games.

Futuremark declined to comment on the issue for this article. However, its release notes for Build 340 of 3DMark03 state that it was meant to disable any optimizations in current video card drivers. In other words, if a driver change only boosts performance in a benchmark program, not every game or application, Futuremark considers it a cheat.

"Nvidia works closely with developers to optimize games for GeForceFX. These optimizations (including shader optimizations) are the result of the co-development process," says Nvidia's Brian Burke. "This is the approach Nvidia would have preferred also for 3DMark03."

"Both Nvidia and Futuremark want to define clear rules with the industry about how benchmarks should be developed and how they should be used," Burke says. "We believe that common rules will prevent these types of unfortunate situations moving forward."

Partly because of this brouhaha, at least one prominent hardware reviewer now eschews benchmark software entirely. Kyle Bennett, *CPU* columnist and owner of [H]ard|OCP (www.hardocp.com) now favors hands-on gameplay and fps testing at a card's best image quality settings as the most important testing methods (page 30, June 2004 *CPU*). ▲

antialiasing, and texture options such as anisotropic filtering.

Sandra Standard 2004. To benchmark your computer with Sandra, scroll down to the test you want to run, such as Memory Bandwidth, CPU Arithmetic, or CPU MultiMedia, and double-click it. If the test doesn't run immediately, click the Refresh button (the one with the blue arrows).

Sandra will display the results in a few minutes or less. You can compare them to other system components using the drop-down menus.

Halo. To log Halo's timedemo fps rate in WinXP, click Start and Run. Type **cmd** in the Open field, and press ENTER. Now type:

```
cd c:\program files\microsoft games\halo
```

You may have to adjust the drive letter or file path if you've installed Halo on a different hard drive partition (such as d:) or in another folder (such as c:\my games\microsoft games\halo). Press ENTER. Next, type:

```
halo.exe -timedemo -vidmode 1600,1200
```

Press ENTER. The –vidmode 1600, 1200 part sets the resolution. You can change this to other values, such as 1024,768, but remember to separate the height and width with a comma as shown. Press ENTER and sit back to watch the demo.

To read the results afterward, close Halo and type the following at the command line (again, adjusting the filepath as necessary). Press ENTER.

```
cd c:\program files\micr osoft games\halo\timedemo.txt
```

So My Scores Mean . . . What?

If you're just benchmarking to see how much faster (or slower) your PC is after a part swap or overclock, it doesn't matter so much what your scores actually are. What matters is how the "befores" compare to the "afters."

On the other hand, if you want to brag that your new 6800 Ultra Extreme can hit such-and-such a 3DMark03 score, you need to make sure that you're setting up your benchmark in the same way as your competitors. For example, Futuremark recommends that you set up 3DMark03 according to its guide (www.futuremark.com/companyinfo/reviewers_guide_3dmark03.pdf) before you publish your benchmark results. There's no point in matching your results against someone else's if you tested in a nonstandard way. Even one difference in settings can alter your final score.

Some benchmarks have features that help you post your scores online or compare them with other users', such as the Aqua-Mark Result Comparator (arc.aquamark3.com/arc/arc_userhome.php) and 3DMark-03's and PCMark's Online Results Browser RB (http://sevice.futuremark.com/servlet/Index?pageid=/orb/index).

FPS. For fps testing in games, your main goal should be to find the highest resolution at which you can turn on all the eye candy you want (antialiasing, game detail, anisotropic filtering) and still have enough frames per second to keep the play smooth. fps rates below 30fps—the frame rate of ordinary TV broadcasts—are considered unplayable. Although you may not be able to consciously distinguish a difference in frame rates much faster than that, there is evidence that your brain can. Faster frame rates might even help you get better scores because the motion on-screen seems more fluid.

New 'Marks

Computer technology doesn't stand still, so benchmark developers often release new versions. "In PCMark04 we introduced test scenarios for multi-CPU and hyper-threaded systems," says Sarkkinen. "Also, we just updated the same benchmark to support the latest 64-bit AMD CPUs."

3DMark03 was the first major benchmark to support DX9's Shader model 2.0, Sarkkinen says, and an upcoming new version will support Shader 3.0. In addition, Sarkkinen says that Future-mark's new benchmark for Symbian-based smartphones should be ready by the time you read this.

Whatever battery of benchmarks you choose to use, it can help your PC be first on race day. CPU

by Marty Sems

The World Records

At press time, this was the latest list of top 3DMark03 (build 340) scores from Futuremark's Hall of Fame (www.futuremark.com/community/halloffame). Each PC ran the benchmark at its default settings with graphics card drivers approved by Futuremark. System specs are as provided by the users.

1.	16802	macci, ATI Radeon X800XT @ 766MHz/651MHz, P4EE @ 4,429MHz (18x246MHz, 1:1 RAM:fsb)
2.	16774	Team Finland (Macci, Kamu & Sampsa) ATI Radeon X800XT @ 760/652, P4EE @ 4,433 (19x 233)
3.	14524	OPPAINTER, ATI Radeon X800Pro @ 717/633, Athlon 64 FX-53 @ 2,976 (248x12)
4.	13540	XtremeResources.com 3D Team (oc-rookie), Radeon X800 Pro 735/640, P4EE 3,400
5.	13478	Jason57570, Sapphire Radeon X800 Pro @ 725/644, Athlon FX-53 @ 3,158 (242x13 @ 1.85v)
6.	13378	FUGGER, P4EE 3,400
7.	12988	X800Pro 16pipes MOD
8.	12486	Team Anti-X (OCSTUPID)
9.	12482	Boogotop X800 Pro
10.	12173	IC7 Anti-X.org

AMD’s Top CPU

The Athlon 64 FX-53

AMD, the "other" processor maker and Intel's fiercest competitor, may not have the kind of name recognition Intel enjoys, but it is quickly redefining itself as a force to be reckoned with. AMD's Athlon 64 series of processors seek not only to fill the 64-bit desktop computing gap left by Intel, but also to demolish AMD's bargain-basement underdog reputation in favor of being the big green cheese. With the release of the Athlon 64 FX-53, the second in a line of Athlon 64 FX processors, AMD has yet again set the bar.

Like its predecessor, the FX-53 uses the 940-pin socket, which is the same socket used for the Opteron family of processors. The ZIF (zero insertion force) socket features a lever that locks down the processor when pushed down flush against the motherboard. To release the chip, simply pull the lever up so it is perpendicular to the board.

AMD manufactures the core of the FX-53 at its Fab 30 wafer fabrication facility in Dresden, Germany, using a 0.13-micron SOI (silicone-on-insulator) process, which fits 105.9 million transistors on the 193mm² die. The processor has a nominal voltage of 1.05.

Inside The Athlon 64 FX-53

In a move to reduce memory latency, AMD has moved the memory controller from the northbridge to the die itself, which brings the transfer speed, usually limited by the memory bus, up to the same frequency as the processor. Another thing to note about the FX-53 is the jump in clock speed. The difference between the 2.2GHz of the FX-51 and the 2.4GHz of the FX-53 may not seem like a lot, but the aforementioned improvements make the FX-53 stand apart as AMD's fastest processor.

64-bit capability. AMD's Athlon 64 FX-53 is not only a high-end processor for 32-bit applications, but it brings 64-bit computing to the home-user arena. The Athlon 64 processors are designed to handle the current 32-bit software, as well as emerging 64-bit software, without the aid of emulators. Although 64-bit applications have yet to really penetrate the home-user market, Microsoft was offering trial versions of Windows XP 64-Bit Edition from its Web site at the time of this writing. In the near future, Epic Games plans to release a 64-bit beta version of Unreal Tournament 2004, and Ubisoft is releasing a 64-bit beta version of Far Cry.

Multimedia instructions. Along with AMD64 instructions, the Athlon 64 FX-53 includes support for SSE (Streaming SIMD Extension), SSE2 (Streaming SIMD Extension 2), Intel's MMX technology, and AMD's 3DNow! technology. Software developers use these instruction sets to improve audio and video encoding, which can enhance game performance.

Cache. The FX-53 features 128KB of L1 cache, which consists of 64KB for instruction and 64KB for data. Aside from the L1, the FX-53 includes a large 1MB L2 cache, which contains both data stream and instruction information. The FX-53’s caches are “exclusive,” which means they are separate, while the Intel Pentium 4 Extreme Edition CPU features “inclusive,” or combined L1 and L2 caches (where the L1 is essentially a part of the L2).

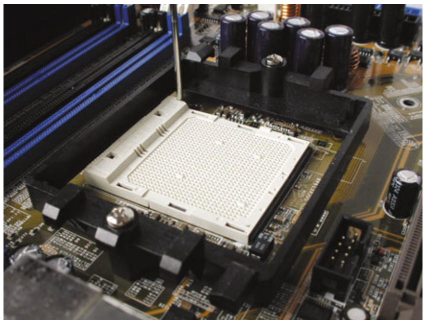
HyperTransport. HyperTransport is a high-speed, low-latency, universal chip-to-chip link, which is faster and more efficient than traditional multilevel buses. HyperTransport technology is the replacement for previous bus technology. The one coherent HyperTransport link found on the Athlon 64 FX-53 consists of a dedicated up and dedicated down channel, each 16-bits wide (32-bit bi-directional), that can transfer data at a maximum 6.4GBps. In addition, the integrated memory controller transfers data at 6.4GBps, for a total system bandwidth of up to 12.8GBps. HyperTransport transmits data at 800MHz, which at double data rate can equal system bus speeds of 1600MHz.

Security. AMD's development team worked closely with Microsoft to optimize Enhanced Virus Protection for its newer processors, including the Athlon 64 FX-53. This feature, enabled by Windows XP SP2, adds a new level of protection against certain viruses such as MSBlaster and Slammer when used in conjunction with antivirus and firewall software.

In The Future

At the time of this writing, the 939-pin socket hadn't quite been released but will be out as you read this. AMD plans to move the Athlon 64 FX family of processors to the new 939-pin socket, leaving the 940-pin socket configuration to the server and workstation Opterons. This also means the Athlon 64 FX-53 will no longer require registered (and more expensive) DIMMs. The AMD64 CPUs are currently the most future-proof processors on the market for consumers. Unfortunately, we'll only see the full benefits of this leap in technology as 64-bit software becomes more prevalent.

by Andrew Leibman



AMD Athlon 64 FX-53	
Clock Speed	2.4GHz
System Bus	1600MHz
L1 Cache	128KB
L2 Cache	1MB
L3 Cache	N/A
Supported Chipsets	NVIDIA nForce3, VIA K8T800, SiS755FX
Supported Memory	Registered DDR PC1600, 2100, 2700, 3200
Manufacturing Process	0.13-micron
Socket Type	940-pin
Special Features: Enhanced virus protection, simultaneous 32- and 64-bit capability, HyperTransport, system bus, integrated memory controller, exclusive L1 and L2 cache	

INTEL'S TOP CPU

The Pentium 4 3.4GHz Extreme Edition

Intel has become a household name, and while some may not understand what Intel does, its name recognition in the computing industry stands second to only Microsoft. Power users know Intel as the industry giant that has led processors into the spotlight, and continues to innovate and refine the technology. With the introduction of the 3.4GHz Pentium 4 Extreme Edition, Intel has pushed the technology even further.

Intel's new 3.4GHz Extreme Edition processor, like its 3.2GHz older brother, works with 875P, 865PE, and 865G chipsets, and fits into a 478-pin socket. The processor secures to the motherboard via a ZIF socket, which features a lever that locks the chip down when flush with the board and unlocks it when pulled up. As we go to press, Intel is getting ready to shift the Extreme Edition, as well as Prescott, over to a 775-pin LGA socket.

The 3.4GHz P4 EE, based on the Northwood core, is manufactured using a 0.13-micron process, with 178 million transistors on a hefty 237mm^2 die. The processor has a nominal voltage of 1.525.

Inside The Extreme Edition

Intel's flagship processor is aimed at the high-end consumer looking for the absolute pinnacle in 32-bit CPU performance. Aside from the blistering 3.4GHz clock speed, the latest Extreme Edition features an advanced 800MHz system bus, which provides 6.4GB of data per second into and out of the processor. The 800MHz data transfers result from a buffering scheme and quad-pumping the data transfers over a 200MHz clocked system bus.

Multimedia instructions. The Pentium IIIs include Intel's MMX microprocessor technology, which allows a single instruction to run simultaneously on multiple data items. Think of it like flipping one light switch to turn on several lights throughout your house. Along with these, the P4 adds new forms of 128-bit SIMD (Single Instruction Multiple Data) instructions called SSE2 (Streaming SIMD Extension 2). While SSE instructions are 128-bit packed IEEE single-precision floating-point operations, SSE2 instructions support 128-bit packed IEEE double-precision SIMD floating-point operations, and 128-bit packed integer SIMD operations. On a basic level, this means that software developers can optimize audio and video encoding streams to take advantage of the expanded instruction sets.

Cache. As a part of Intel's NetBurst microarchitecture, the Pentium 4 has an advanced L1 instruction cache, called the ETC (Execution Trace Cache) that can store 12KB of micro-ops, or µops. By removing the decoder from the main execution loop, the ETC is able to store the already decoded µops. As a result, the processor only uses the decoder when the machine misses and needs to go to the L2 cache to get and decode new IA-32 instructions, which makes cache storage space more available.

Along with the 8KB L1 data cache and the 512KB L2 Advanced Transfer Cache, the Extreme Edition features a massive 2MB L3 cache, which is unprecedented in the home-user market. The excessive size of the L3 cache lets it preload a graphics frame buffer or a video frame on-die and retrieve it at native processor frequencies. In short, it improves game performance and speeds up frame rates when accessing memory and I/O devices.

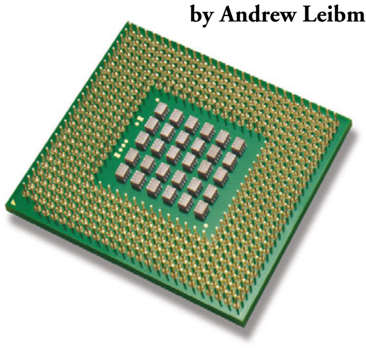
Hyper-pipelining. All Pentium 4 processors have a 20-stage instruction pipeline compared to the 10-stage instruction pipeline of the Pentium IIIs. Intel has built their reputation on high clock speeds, which are possible because the Pentium 4s have twice the stages, allowing the CPU to do less work during each pipeline stage. One drawback to this strategy is that the CPU's per clock cycle efficiency decreases as a result of deeper pipelines.

Hyper-Threading Technology. HT Technology allows the processor to execute two software program threads at the same time, which, under normal circumstances, would sacrifice performance. Hyper-Threading-enabled Pentium 4 processors don't suffer that performance hit because HT Technology tricks the system into thinking it has two processors, which translates to up to 25% faster performance than non-HT-enabled Pentium 4s. HT is particularly helpful for audio and video encoding and generally improves the processor's ability to multitask.

What's Coming . . .

An Intel spokesperson we talked to said that the Pentium 4s should reach 4 GHz by the end of the year. Despite this, Intel is looking to focus less on the clock speed and more to the other features, such as bus speed and cache sizes to more accurately identify their processors. With regard to an Itanium-based processor capable of 64-bit computing for the home-user market, Intel says it wants to wait until more 64-bit applications hit the market, but offered no further comment.

by Andrew Leibman



Intel 3.4GHz Pentium 4 Extreme Edition	
Clock Speed	3.4GHz
System Bus	800MHz
L1 Cache	8KB
L2 Cache	512KB
L3 Cache	2MB (on die)
Supported Chipsets	875P, 865PE, 865G
Supported Memory	Dual DDR400/333/266 SDRAM
Manufacturing Process	0.13 micron
Socket Type	478-pin

Special Features: Hyper-pipelining/Hyper-Threading, Rapid execution engine, Execution trace cache, Advanced transfer cache, Advanced dynamic execution

GRANTSDALE GRANTS INTEL USERS' WISHES

New i915 Chipset Adds Many New Technologies

Intel's Grantsdale, also known as the Intel 915 chipset, is on the horizon, likely to premiere just before this issue hits newsstands. The chipset should drastically alter the face of Intel-based computing, thanks to a variety of new technologies.

Grantsdale will replace the Intel 865 chipset but will not support Win98/Me. Also, because Intel incorporates many proprietary technologies in Grantsdale, motherboard options may initially be limited. How quickly manufacturers adopt the technology and pay the associated licensing fees depends upon how well Intel pushes the chipset's many groundbreaking features.

Northbridge Features

Grantsdale stands out for its support of the new DDR2 memory. Although initial DDR2 modules will not offer significant speed improvements over DDR, eventually DDR2 will see considerable speed boosts. Also, DDR2 systems generate less heat than DDR systems. Grantsdale's northbridge is backward-compatible with DDR.

Grantsdale also includes many video enhancements. Most notably, the chipset includes PCI Express x16, which offers much higher bandwidth than the previous high-end video standard AGP 8X. Current video cards act as a bottleneck to PCI Express x16's speed enhancements, but as video card technology matures, Grantsdale will take advantage of PCI Express x16's speed.

The chipset comes in a 915G configuration with integrated Extreme Graphics 3, which is a significant improvement over Extreme Graphics 2. However, third-party video cards will still provide the best graphics quality.

Intel links Grantsdale's northbridge and southbridge with a new technology called DMI (Direct Media Interface), which handles speeds of about 100MHz between the northbridge and southbridge and clock speeds of about 1GBps.

Southbridge Options

When the ICH6-R southbridge is paired with the i915 northbridge, Grantsdale supports up to eight SATA ports. The southbridge supports RAID 0, 1, and 0+1 for additional storage and data security.

Another option is the ICH6-W southbridge, which has a built-in WAP with support for 802.11a/b/g WLANs. This lets a computer act as a WAP, a useful function for both business and home users. While a business user may use a Grantsdale system to create a wireless network and access work files, a home user may use a Grantsdale system to send digital video from a PC to a compatible home entertainment system.

Users who want to use Grantsdale with a home entertainment system will appreciate Intel's HD Audio technology (formerly called Azalia), which features Dolby Pro Logic IIx for 7.1-channel audio. Dolby Pro Logic IIx converts 5.1-audio input into 6.1- or 7.1-channel output. Dolby Pro Logic IIx has three modes, Movie, Music, and Game, to provide the most appropriate output for playing on the PC. The Music mode can produce Center Width (vocals balanced in front left, center, and front right channels), Panorama (which creates a wraparound effect), or Dimension (which alters the depth of the surround sound) output.

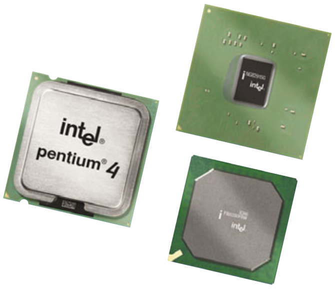
In addition, HD Audio includes automatic audio-jack remapping. When a user plugs an audio device, such as a microphone or speaker, into a generic audio jack, the system automatically identifies the hardware type and maps the device appropriately. All Grantsdale-compatible CPUs will have built-in HD Audio.

More Grantsdale Features

Finally, Grantsdale supports the new BTX (Balanced Technology Extended) form factor, a motherboard specification for systems with small footprints and slim designs. BTX-compliant components are laid out on the motherboard in such a way that airflow is not blocked or disrupted by parts. Grantsdale systems and other BTX systems will run cooler than most non-BTX competitors and may require fewer cooling components. BTX boards are also designed to better withstand the weight of heavy components.

Intel will release another chipset at the same time as Grantsdale. If you want even more power than Grantsdale offers, Alderwood (Intel 925) adds a few additional features and works best with the high-performance, but pricey Intel Pentium 4 Extreme Edition processor. CPU

by Kylee Dickey



Intel Grantsdale Chipset	
Northbridge (i915)	
FSB	Expected to be 800MHz
Supported Processors	Intel Pentium 4
Supported Memory	Dual-channel DDR2, dual-channel DDR
Maximum Memory	(not announced at press time)
Integrated Graphics	Extreme Graphics 3 (with 915G chipset)
Graphics Interface	PCI Express x16
Southbridge (ICH6-R or ICH6-W)	
IDE/SATA	Support for up to eight SATA ports
RAID	0, 1, 0+1
Networking	10/100/1000 Ethernet, integrated WAP (with ICH6-W southbridge)
Audio	HD Audio
Features: PCI Express x16, integrated WAP (with ICH6-W southbridge), RAID 0/1/0+1, DDR2 support, HD Audio, Extreme Graphics 3, DMI (Direct Media Interface), support for up to eight SATA ports, BTX form factor, and Dolby Pro Logic Iix with 7.1-channel audio	
Estimated Release Date	Late June 2004

SPECIAL FX

SiS Adds Support For AMD's Athlon 64FX CPU

When SiS introduced the 755FX chipset in November, it boasted that the chipset was the first to support the 939-pin Athlon 64FX CPU. The 755FX also provided a 1GHz HyperTransport interface for faster data transfer. We used the 755FX chipset in the "AMD Athlon 64 3400+ & ECS 755-A2" and "AMD Athlon 64 3000+ & Jetway S755MAX" articles on pages 68 and 81 in this issue. Shortly after we ordered parts, SiS released the SiS 756 chipset. Specs for the 756 chipset are in the AMD-Compatible Chipsets chart on page 196.

In addition to support for AMD's Athlon 64FX, the SiS 755FX also supports AMD 64 and AMD Opteron CPUs. Neither the 755FX nor the 756 support Athlon XP, and as far as we can tell, SiS plans no further Athlon XP chipsets.

Northbridge Features

The SiS755FX northbridge has a FSB of 1,000MHz and a transmission speed of up to 8GBps. The chip supports AGP 8X/4X external graphics, which is noteworthy because the SiS755FX is likely to be the last SiS chipset to carry AGP 8X support. The new SiS 756 supports only the new PCI Express x16 and PCI Express x4 technologies.

SiS' HyperStreaming Engine technology provides the 755FX with multiple pipelines through which data can travel, eliminating delays and "bottlenecks" in data transmission. The HyperStreaming Engine also reserves a channel for multimedia data transmissions for higher quality video streaming and videoconferencing.

Other northbridge features include Fast Write Transaction and STR support. Depending upon the CPU coupled with the SiS 755FX, the northbridge can accept up to 3GB of memory through three DDR400 DIMMs at bandwidths of up to 3.2GBps.

The 755FX links the SiS755FX northbridge and southbridge (currently either SiS964 or SiS965) with MuTIOL 1G technology's 16-bit, bidirectional data bus (1GBps in 133MHz x 4 mode).

Southbridge

There are currently two southbridge pairings for the SiS755FX northbridge. The first is the SiS964, which was released at the same time as the SiS755FX northbridge. The second option is the SiS965, which SiS introduced on Feb. 25 of this year. Both southbridge chips include an impressive list of features, but the SiS965 is guaranteed to wow many users.

SiS964. The SiS964 southbridge provides a number of features to the SiS 955FX chipset. It adds two independent SATA 150 ports (for data transfer rates of up to 150MBps for storage devices), eight built-in Hi-Speed USB 2.0 ports, AC'97 5.1-channel surround sound, 10/100-BaseT Ethernet, v.90 modem support, dual-channel parallel ATA 133/100/66, and RAID 0, RAID 1, and JBOD.

SiS965. The newer southbridge chip, the SiS965, adds several enhancements over the SiS755FX/SiS964 pairing. SiS965 motherboards have four SATA ports rather than two. Users will also see an improvement in networking and audio. Ethernet support is propelled from 10/100-BaseT to Gigabit Ethernet connectivity. Audio gets a big boost, too, advancing from 5.1-channel AC'97 to 7.1-channel surround sound through the AC'97 2.3 standard. In addition to the SiS964's 10/100Mbps Ethernet and the SiS965's Gigabit Ethernet, both southbridge chips include 1/10Mbps HomePNA for affordable home networking through a phone line.

64-bit Support For SiS-based Motherboards

If one thing is certain, it is that SiS eagerly pounced on AMD's latest technology. As the first chipset for the AMD Athlon 64FX processor, the SiS 755FX chipset with SiS964 southbridge offered a full set of features to Athlon 64FX-compatible motherboards. Just a few months later, SiS rolled out the SiS965 southbridge, which adds numerous improvements to its AMD 64FX-compatible boards. The SiS 755FX chipset, as the last SiS chipset to support the AGP 8X external graphics interface, has left an impact on AMD Athlon 64FX computing.

by Kylee Dickey

SiS 755FX Chipset	
Northbridge (SiS755FX)	
System Bus	1,000MHz
Supported Processors	AMD Athlon 64, AMD Athlon 64FX, AMD Opteron
Supported Memory	Three DDR400 DIMMs (dependent upon CPU support)
Maximum Memory	3GB (dependent upon CPU support)
Integrated Graphics	N/A
External Graphics Support	AGP8X
Additional Northbridge Specs	HyperTransport
Southbridge (SiS964 or SiS965)	
IDE/SATA	Supports ATA133/100/66 (SiS964), ATA133/100 (SiS965), two SATA ports (SiS964), four SATA ports (SiS965)
RAID	RAID 0, 1, JBOD
Networking	10/100 Base-T (SiS964), 10/100/1000 Base-T (SiS965)
Audio	AC'97 5.1-channel (SiS964), AC'97 2.3 7.1-channel (SiS965)
Features: MuTIOL 1G multithreaded I/O Link (1GBps), eight integrated Hi-Speed USB 2.0 and Full Speed USB controllers, supports six PCI slots (SiS964), supports six PCI2.3 slots (SiS965), supports two PCI-Express x1 slots (SiS965)	
Released: Nov. 13, 2003 (SiS755FX northbridge and SiS964 southbridge); Feb. 25, 2004 (SiS965 southbridge)	

CHIPSET ENTERTAINMENT

VIA's PM880 Chipset Ready For Media PCs & HDTV

VIA's latest Intel Pentium 4 chipset, the PM880, is designed for multimedia applications such as playing DVDs in a media center PC. As a specialized chipset, the PM880 will meet the needs of its target users very well, but may not be ideal for other users, such as gamers. This chipset was just released in March. PM880 motherboards were not yet available when we built systems for this issue. However, VIA's PM880 has a number of features, including S3 Graphics UniChrome Pro IGP, that make it worth covering.

Northbridge Features

The PM880's northbridge supports a variety of display technologies, including CRT, LCD, and, most notably, HDTV (including resolutions of up to 1,080p). The PM880 northbridge includes a Chromotion CE Video Display and a built-in decoder engine that handles much of the processing, compression, decompression, and decoding of MPEG-1 and MPEG-2 video. A VIA PM880 system is unique because the chipset carries out those tasks rather than loading video decoding onto the processor. Therefore, a PM880-coupled processor does less work and runs cooler. The MPEG-2 decoder is compatible with many familiar DVD-playback programs, including CyberLink Power-DVD, InterVideo WinDVD, and Microsoft Windows Media Player.

The Chromotion CE Video Display applies a number of video-rendering technologies to DVD playback. For example, ADT (Adaptive De-interlace Technique) optimizes video display by determining the best display technology on a pixel-by-pixel basis. ADT selects either the Bob or Weave process for each pixel of video on a progressive-scan display. Bob technology produces better results in video with motion, and Weave technology results in better video in relatively still scenes. ADT evaluates which pixels represent moving objects and applies Bob technology to those pixels, while at the same time applying Weave technology to pixels that represent still objects. Another key technology in the Chromotion CE Video Display is video deblocking, which enhances images to make compressed video look less pixelated on-screen.

The most notable trade-off for the PM880's video-display features is its 200MHz, 3D graphics engine, which incorporates a UMA, sharing 64MB of the overall system memory. This is not a problem if you buy a PM880 motherboard for its intended use in a media center PC, but will be an issue in a high-performance or gaming system.

Other northbridge features include AGP 8X support for an add-on video card, a DualStream 64 dual-channel DDR400 memory controller with support for up to 8GB of DDR400/333/266 SDRAM, Hyper-Threading support, video acceleration, multimonitor-display capabilities, three 12-bit digital-video ports, video-capture ports, and an 800MHz FSB.

Southbridge Features

Although not as feature-rich as the northbridge, the VIA VT8237 southbridge adds several features to a PM880 board. The VT8237 supports four PATA 133/100 ports and up to four SATA devices, and RAID 0, RAID 1, RAID 0+1, or JBOD (Just a Bunch Of Disks; a group of hard disks that acts as a single volume) configurations. The southbridge also has built-in Gigabit Ethernet.

The southbridge includes VIA Vinyl Audio with six-channel audio support through the VIA Six-TRAC AC'97 audio codec. The VT8237 also supports VIA Vinyl Gold Audio with eight-channel surround sound when the chipset is built into a motherboard that includes the VIA Envy 24PT PCI audio controller. Finally, the VT8237 supports eight USB 2.0 ports.

A Specially Tailored Chipset

The new VIA PM880 chipset was designed for a distinct type of system and does not compete directly with the other chipsets we covered in this section. However, the advanced video capabilities and number of features make this a strong offering by VIA.

by Kylee Dickey

VIA PM880 Chipset	
Northbridge (PM880)	
System Bus	800MHz/533MHz/400MHz
Supported Processors	Intel Pentium 4
Supported Memory	dual-channel DDR400/333/266
Maximum Memory	8GB
Integrated Graphics	S3 Graphics UniChrome Pro IGP
External Graphics Support	AGP 8X/4X
Additional Northbridge Specs	
DualStream 64 Dual-Channel DDR400 memory controller, Hyper-Threading support, video acceleration, multimonitor display support, video-capture ports, UMA (Unified Memory Architecture)	
Southbridge (VT8237)	
IDE/SATA	four PATA 133/100 ports, up to four SATA devices
RAID	RAID 0, RAID 1, RAID 0+1, and JBOD
Networking	Gigabit Ethernet
Audio	VIA Vinyl Audio with six-channel audio support through VIA Six-TRAC AC'97 audio codec and VIA Vinyl Gold Audio with eight-channel audio support through VIA Envy 24PT PCI audio controller
Features: Hi-Def video HDTV output up to 1,080p, MPEG-2 decoding, 2D/3D graphics engine, Chromotion CE Video Display Engine, dual 128-bit pipelines, SATA, V-RAID, VIA Vinyl Audio, Gigabit Ethernet with VIA Velocity controller, part of V-MAP (VIA Modular Architecture Platform), Ultra V-Link (1GBps), eight Hi-Speed USB 2.0 ports, three 12-bit digital video ports	
Released	March 12, 2004

MAY THE FORCE BE WITH YOU

NVIDIA's nForce3 Chipset

NVIDIA's nForce2 wowed the masses with its integrated graphics, networking options, and audio technology. NVIDIA's newest single-chip MCP chipset, the nForce3, may be even more impressive than its predecessor.

With its single-chip design, the nForce3 operates with low latency. nForce3 systems also run cooler, thanks to the combination of northbridge and southbridge features in a single chip.

Whereas the nForce2 worked with AMD's Athlon XP processor, the nForce3 has dropped Athlon XP support, instead graduating to 64-bit computing. The nForce3 MCP is compatible with AMD's Athlon 64 and Athlon 64FX CPUs. An nForce3 Pro chip is compatible with the 64-bit Opteron processor.

Many of the nForce2's features, such as DualNet, FireWire, and NVIDIA SoundStorm audio, are absent from the nForce3. The new chipset focuses more on networking and RAID support. The 2Gb nForce3 MCP even integrates the hardware-based, network-level NVIDIA Firewall and Gigabit Ethernet. The firewall includes advanced configurations, such as remote access and CLI, but also a novice-friendly configuration wizard

StreamThru Data Transport technology with an isochronous controller makes network data transmissions more efficient and smoothes streaming audio and video. A HyperTransport link connects the nForce3 to an Athlon 64FX or Athlon 64 CPU (or the nForce3 Pro to an Opteron CPU) at up to 8GBps.

Southbridge Features

The nForce3 integrates hardware-accelerated RAID with support for RAID 0, RAID 1, and RAID 0+1 configurations. Support for up to six ATA/133 devices is built into the nForce3. SATA support is also included, and nForce3 250Gb boards include disk-independent SATA controllers

The nForce3 supports HomePNA 2.0 PHYs and 10/100-BaseT Ethernet. The nForce3 250Gb chipset also has built-in Gigabit Ethernet. The nForce3's network features include ASF, autonegotiation, flow control, traffic prioritization, and support for IPv6, TCP segmentation, and TCP/IP offload.

The MCP supports up to eight Hi-Speed USB 2.0 ports and AC'97 2.1 audio for up to six channels of output. A Dual AC-Link allows up to two audio codecs. nForce3 systems can incorporate S/PDIF output to either stereo or AC-3. NVIDIA's NVMixer Application lets users adjust audio settings, such as recording options and speaker settings. SoundStorm audio technology may be available as an add-on companion chip in the future.

Northbridge Features & Other Highlights

Most of the nForce3's most impressive features are those typically found in a southbridge chip. However, NVIDIA's latest MCP does have a couple of northbridge features. First, the nForce3 supports AGP 8X and AGP 4X for add-on video cards. HyperTransport Technology improves data communications and supports transmission rates of up to 800MBps.

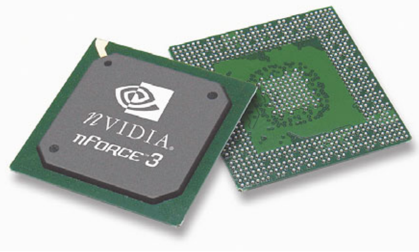
As with all of NVIDIA's products, the nForce3 follows NVIDIA's UDA (Unified Driver Architecture), which ensures that NVIDIA's products will be compatible with past and future software drivers.

The UDA is part of the wider NVIDIA ForceWare USE (Unified Software Environment). This set of utilities lets users monitor systems, configure system components, and use a variety of system tools. As with the UDA, NVIDIA supports the USE across its product line.

Finally, it is worth mentioning that NVIDIA manufactures the nForce3 through a 0.15-micron process rather than the 0.22-micron process that is standard with other chipsets in the industry. The resulting smaller size of the nForce3 leaves more room on the motherboard for manufacturers to add companion chips, additional slots, and other features to their nForce3 boards.

NVIDIA's new chipset will likely attract the most attention simply because of its support for AMD's 64-bit processors. However, a number of storage, networking, and other features make the nForce3 more than simply a chipset for 64-bit computing.

by Kylee Dickey



NVIDIA nForce3 MCP (single-chip chipset)	
Northbridge	
System Bus	Up to 400MHz
Supported Processors	AMD Athlon 64FX, AMD Athlon 64
Supported Memory	DDR400/333/266
Maximum Memory	2GB
Integrated Graphics	N/A
External Graphics Support	AGP 8X/4X
Southbridge	
IDE/SATA	Built-in SATA disk controller and ATA/133 disk controller
RAID	0, 1, 0+1
Networking	Built-in Gigabit Ethernet (with nForce3 250Gb)
Audio	N/A
Features: Single-chip MCP design, built-in hardware-based firewall (nForce3 2Gb only), 64- and 32-bit support, up to eight Hi-Speed USB 2.0 ports, comes with NVIDIA ForceWare USE (Unified Software Environment; with system-monitoring and configuration utilities), wide support from motherboard manufacturers, integrated chipset processor, and StreamThru Data Transport	
Released	Sept. 23, 2003

ESSENTIAL OVERCLOCKING UTILITIES

Power Modding Is As Much About The Right Software As The Right Hardware

When you overclock a system, you want to have the best tools on hand. Of course, you want the right system components and an effective cooling system, but the right software can also aid your quest for speed. There is a variety of utilities available to help you adjust system settings, monitor your system's performance, control temperatures, detect hardware failures, prevent component damage, and get the best overclocks possible.

The Basics Of OC Utilities

The operation of these programs varies, but several of the utilities maintain lower CPU temperatures by sending the processor an instruction to sleep or consume less power when it is not active. This is especially helpful for Windows 9x systems, which do not automatically perform any such procedure. Later versions of Windows issue commands to the CPU during idle time.

Other overclocking utilities perform advanced system monitoring so you are aware of the effects of your overclocking efforts, including sudden spikes in power usage or CPU temperatures. Many utilities aid in overclocking by sounding alarms or shutting down the system if the components overheat or if a fan fails. Many overclocking utilities can monitor system temperatures, voltages, and fan speeds, provided that your motherboard has built-in sensor chips that can detect such system changes. Controlling the temperatures within your PC can not only increase your odds of a successful overclock, but can also increase the life of your computer and its components.

There are also several utilities available that let you adjust overclocking settings, such as the FSB and core voltage, without entering the BIOS or rebooting your system. By taking advantage of the best overclocking utilities for your system, you can usually push your system further and also prevent component failure.

Finally, some utilities are stress tests and are not designed to improve or monitor system performance. Instead, these utilities run a series of resource-intensive tasks designed to tax the CPU and other system components. After a successful overclock, you should run one of these utilities designed to place a heavy workload on your system. If your overclocked system cannot run one of these programs for several hours, you probably need to work to make your system more stable before using it in an overclocked state for everyday use.

Intel Active Monitor 1.2
Bundled with Intel motherboards
www.intel.com/design/motherbd/active.htm

Although most of the utilities we'll cover have been written by individual programmers or by smaller companies, some larger companies provide their own overclocking tools with their motherboards. For a summary of some of the overclocking utilities that ship with popular motherboards by manufacturers, such as AOpen, ASUS, Chaintech, and Leadtek, see the "Motherboards With Great Utility" chart on page 28.

One example of a motherboard manufacturer that bundles a useful overclocking utility is Intel. Typically, Intel's motherboards are not very overclock-friendly, but its Intel Active Monitor utility can perform several useful functions for the overclocker. Intel Active Monitor is available with desktop motherboards based on Intel technology.

Active Monitor consumes less than 1% of system resources and tracks system temperatures, voltages, and fan usage. The software notifies the user if a failure occurs. For instance, if the processor begins to overheat or if a fan stops working properly, Active Monitor will provide on-screen notification. Alert options include pop-up dialog boxes, alert tones, and altering the Active Monitor icon in the System Tray. Active Monitor also displays basic system information, such as processor type and speed, motherboard, integrated chipset, and installed memory.

If you buy a motherboard based on a 915G or 915P chipset (Grantsdale), a 925X chipset (Alderwood), or a newer chipset, you cannot use Intel Active Monitor. Instead, Intel will provide a new, similar application called Intel Desktop Utilities.

PassMark BurnInTest Professional 4.0
$49 ($22 for Standard, $24 for PerformanceTest, $34 for Standard + PerformanceTest)
www.passmark.com

PassMark's BurnInTest Professional is useful for testing the stability of various system components when overclocking. BurnInTest runs a variety of stress tests to simultaneously test each of a PC's major operations. These tests will expose any problems with components' stability and endurance before you begin using the system for day-to-day use after overclocking. Although the stress tests could cause a system component to fail, it should fail immediately rather than days or weeks later when you could lose critical data from such a failure.

BurnInTest is multithreaded and simultaneously taxes the processor, memory, hard drives, sound cards, video cards, and optical drives to ensure that the system is stable. In fact, it can test a combination of up to 20 hard drives, floppy diskettes, and optical drives at the same time. It also tests network connections, printers, and video playback. A Standard Edition is available, but does not test tape drives or ports (USB 1.x/2.0, serial, and parallel).

Although BurnInTest does not support DOS, it does support Windows 98/Me/2000/XP/2003 Server. You can log the results of the utility's stress tests on disk in either ASCII or HTML format. You can also export log results to other programs in BMP, GIF, or EMF format. You can even add your own notes to the Notes and Machine ID fields of a log file. Finally, BurnInTest supports sending logs to a printer.

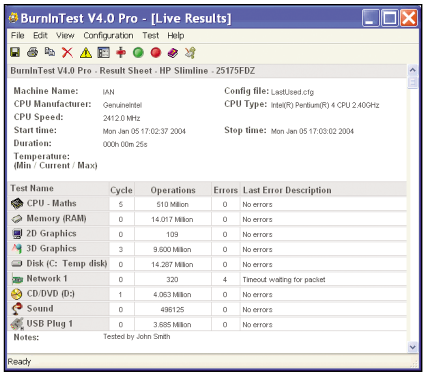
BurnInTest is highly customizable and lets users designate the load to place on each component during a stress test. The software keeps a running count of operations performed and summarizes this information along with basic system information, such as CPU type, speed, and serial number.

You can try BurnInTest for 30 days before paying for a $49 license. BurnInTest is compatible with several common temperature-monitoring utilities, including Intel Active Monitor, HMonitor, MotherBoardMonitor, and SpeedFan. The Pro edition includes several perks that the Standard edition lacks. One of the most notable is that the Pro edition can not only test dual- and quad-processor systems, but it can also test only a single CPU within a multiprocessor system.

CPU Monitor
Freeware
jongrieve.net/cpumon

CPU Monitor is a CPU-monitoring utility for Win9x, single-processor system. Newer versions of Windows are not supported because the newer Windows OSes perform the same basic functions as CPU Monitor. CPU Monitor's operation is fairly simple. An icon in the System Tray graphically represents real-time CPU usage. As your computer performs various tasks, you can watch the CPU usage peak or drop back to near-idle levels.

You can see a more detailed analysis of your CPU usage in the Details dialog box. There, CPU Monitor displays processor usage information in graph format.



BurnInTest V4.0 Pro - Result Sheet - HP Slimline - 25175FDZ

Machine Name: IAN
CPU Manufacturer: GenuineIntel
CPU Speed: 2412.0 MHz
Start time: Mon Jan 05 17:02:37 2004
Duration: 000h 00m 25s
Temperature: (Min / Current / Max)
Config file: LastUsed.cfg
CPU Type: Intel(R) Pentium(R) 4 CPU 2.40GHz
Stop time: Mon Jan 05 17:03:02 2004

Test Name	Cycle	Operations	Errors	Last Error Description
CPU - Maths	5	510 Million	0	No errors
Memory (RAM)	0	14.017 Million	0	No errors
2D Graphics	0	109	0	No errors
3D Graphics	3	9.600 Million	0	No errors
Disk (C: Temp disk)	0	14.287 Million	0	No errors
Network 1	0	320	4	Timeout waiting for packet
CD/DVD (D:)	1	4.063 Million	0	No errors
Sound	0	496125	0	No errors
USB Plug 1	0	3.685 Million	0	No errors

Notes: Tested by John Smith

BurnInTest Professional displays system info and summarizes system performance during its tests.

CpuIdle Extreme
$30
www.cpuidle.de

CpuIdle is one of the longest-running overclocking utilities, developed by Andreas Goetz. It operates by using a virtual driver (cpuidle.vxd) to run an HLT command that suspends operation of the processor in Win9x systems. The HLT command is executed in Ring 0 of the Win9x kernel, a portion of the Win9x architecture that other programs do not access. In fact, the first release of CpuIdle did not operate in Ring 0, and as a result the utility did not work. A VxD named cpuidle.vxd was added to CpuIdle and future versions and now issues the HLT commands in Ring 0.

CpuIdle acts to keep the processor cool and, as a result, makes the entire system more stable. The utility lets you monitor both the CPU idle and cooling times from an on-screen display. The software can read MBM sensors, monitor the temperature, and act accordingly to cool the system if possible or shut the system down if temperature issues are critical.

When the processor needs to wait for another device before it can proceed, an HLT command from CpuIdle tells the system to stop the clock. The processor enters suspend mode, which saves power and keeps temperatures low. The CPU stays in suspend mode until there is an interrupt, NMI, or reset.

If your processor has built-in power-saving technology, the HLT command will also send the processor into powersaving mode. CpuIdle continues to run and control your PC's temperature, even when you're using your system. Therefore, it is one of the more proactive programs, as it can kick in and control the CPU temperature even as you perform other computer-related tasks. CpuIdle also optimizes the operation of the motherboard's chipset to ensure the coolest operation possible.

Using CpuIdle can be a little bit disconcerting if you monitor the CPU usage. When the utility runs, CPU usage registers at 100% because CpuIdle uses all excess processor idle time to send the HLT commands that keep the system running as cool as possible.

CpuIdle boasts support for most current processors. Those newer processors that do not have official support may still work with CpuIdle through its generic support for processors and chipsets. CpuIdle also works even with dual- and multiprocessor systems.

CpuIdle is compatible with the temperature-monitoring utility MotherBoard Monitor. A Win9x/Me-compatible copy of CpuIdle costs $20. The WinNT/XP edition is called CpuIdle Pro and costs just $30. CpuIdle Extreme was released at the end of 2003 and supports a number of chipsets not supported by previous editions of CpuIdle. The Extreme edition supports VIA KT600, SiS 730, SiS 733, SiS 735, SiS 746, SiS 748, and SiS 755. It also lets you disable CpuIdle automatically when designated programs are running. CpuIdle Extreme is available for Win9x/NT/Me/XP and costs $30. The price of all editions of the CpuIdle utility include free product upgrades.

According to the authors of CpuIdle, even though WinNT/2000/XP have built-in HLT instructions during CPU idle time, the OS does not take full advantage of potential HLT commands. These versions of Windows can only send the HLT command when the OS recognizes the BIOS and ACPI implementation. Although users can expect to see greater improvements with the CpuIdle on a Win9x/Me system, users should still see some benefits from using CpuIdle on a WinNT/2000/XP system.

Finally, CpuIdle performs one other function to halt the CPU and keep a system cool. Many newer chipsets will only allow the processor to be stopped after they are programmed to allow HLT instructions. This process is known as chipset optimization, and CpuIdle can ensure that the chipset does not interfere with the execution of an HLT command. CpuIdle is compatible with most older and modern processors and chipsets. A complete list of supported hardware is available at www.cpuidle.de/features.html#cpus and www.cpuidle.de/features.html#chipsets.

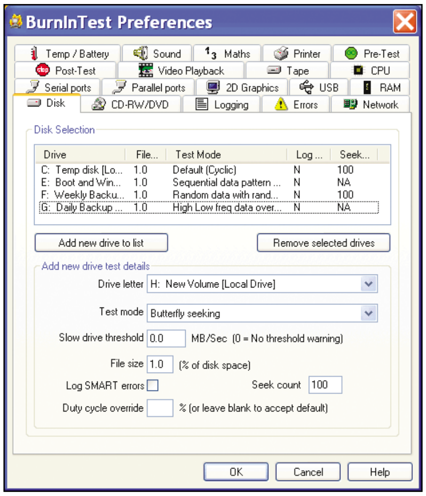
CTemp 3.0

Freeware

strip.se/prog/ctemp.html

CTemp is a 16-bit application that is compatible with Win9x and OS/2. CTemp 3.0 is written for Asus TX-series motherboards but, according to the software's author, may work with motherboards with the LM75 or LM78 sensor chips. CTemp displays voltage and the temperature of both the processor and motherboard in either degrees Celsius or Fahrenheit. If temperatures rise above a safe level, a warning appears on screen. Built-in temperature-correction tools are also included, and you can select a data refresh rate ranging from one second to 99 seconds.

Other editions of CTemp are available, including CTemp LT 1.0, which monitors only the motherboard. This is the recommended edition for those whose motherboards don't include CPU sensor chips. The other CTemp utility is CTemp MINI 1.0, which is like CTemp LT, except that it does not monitor voltages and lacks on-screen alarms.



Drive	File...	Test Mode	Log ...	Seek...
C: Temp disk [Lo...	1.0	Default (Cyclic)	N	100
E: Boot and Win...	1.0	Sequential data pattern ...	N	NA
F: Weekly Backu...	1.0	Random data with rand...	N	100
G: Daily Backup ...	1.0	High Low freq data over...	N	NA

Drive letter H: New Volume [Local Drive]
Test mode Butterfly seeking
Slow drive threshold 0.0 MB/Sec (0 = No threshold warning)
File size 1.0 (% of disk space)
Log SMART errors ☐ Seek count 100
Duty cycle override % (or leave blank to accept default)

Several overclocking utilities, such as BurnInTest Professional, let you configure settings for more devices than just the CPU.

Gigabyte EasyTune 4

Bundled with some Gigabyte motherboards

www.giga-byte.com

EasyTune 4 is a user-friendly application that comes with many Gigabyte motherboards. This software performs the standard operations, such as monitoring system temperatures, voltages, and fan speeds. It tracks not only power usage for the CPU, but also the AGP bus and the memory. If system components start to overheat, EasyTune 4 will sound an alarm. Similarly, if a cooling fan fails, the utility will warn the user.

Users can tweak BIOS settings and overclock a system from within EasyTune 4 rather than entering the BIOS to nudge the system's performance. Although EasyTune lets users adjust the FSB, CPU multiplier, CPU voltage, AGP voltage, and memory voltage in the utility's Advanced mode, there is also an Easy mode that provides fewer power modding options, but that makes overclocking simple for the novice.

JAM HeavyLoad 2.0

Mailware (freeware, but requires that you email or send a postcard)

www.jam-software.com

JAM Software also makes a utility that can help you test the stability of an overclocked system. HeavyLoad does exactly what its name suggests: stresses various PC components, such as the processor, memory, and hard drive. You can use HeavyLoad to test the stability of your system after an overclock. As with most utilities that test the stability of a system, HeavyLoad provides the most reliable results when you let it run for several hours. Usually a minimum of six hours is suggested.

HeavyLoad works by writing a large file to the temp folder. It also does other work, such as drawing continually evolving patterns in an on-screen window and allocating physical and virtual memory. You should restart Windows after running HeavyLoad because the program tends to fragment system memory as it runs.

HeavyLoad is mailware, free to use but with the stipulation that you send the authors an email message or postcard indicating which version you use, how you found it, and any errors you've encountered.

Hmonitor 4.1 Pro

$29 (one- or two-system, personal-copy license)

www.hmonitor.com

Hmonitor is one of the better-known OC utilities. As its name suggests, it monitors the heat and voltage of the motherboard, but it can also control CPU operation, as well.

The most recent version at press time is Hmonitor 4.1. This utility by Alexander Berezkin is also known as Hardware Sensors Monitor. It monitors both the system and CPU temperatures using a motherboard's sensor chips. A list of compatible sensor chips is posted at www.hmonitor.com/hmonfaq.html#General. In addition to tracking temperatures, Hmonitor also monitors system voltages and the operation (or failure of) any cooling hardware.

The Hmonitor icon appears in the System Tray for quick access to the data it collects. When a system overheats, Hmonitor can sound an alarm, shut down the system, or, with the corporate edition of Hmonitor, email a system administrator.

A Lite edition of Hmonitor is also available, as are a variety of licenses, including personal-use and corporate-use licenses.

Hmonitor is compatible with Win9x/NT/Me/2000/XP. The first month of usage is free, after which you must buy a license. The software supports most current CPUs, including even 64-bit processors, such as AMD's Athlon 64.

Motherboard Monitor 5.3
Freeware
mbm.livewiredev.com

Alexander van Kaam's Motherboard Monitor is a common name in the overclocking world. This freeware monitors temperatures and voltages from a sensor chip on the motherboard. Whereas some programs (such as Ctemp) only work with a very limited number of motherboards and sensor chips, Motherboard Monitor is compatible with a wide selection of chipsets and sensor chips. A full list of compatible motherboards is available at mbm.livewiredev.com/mobolist.html. You can find a list of compatible chipsets at mbm.livewiredev.com/about.html#chipsets and a list of compatible sensor chips at mbm.livewiredev.com/about.html. Motherboard Monitor works with Win9x/NT/Me/2000/XP systems.

At its most basic level, Motherboard Monitor displays sensor chip-provided data, such as voltages and temperatures, in a dialog box that you can access quickly through an icon in the Windows System Tray. Motherboard Monitor goes a step further, also recording this data in a log file for later viewing. It can monitor data both when the system is at full load and when the processor is idle. Motherboard Monitor can also work together with some other utilities, such as Dynamic Worlds' ShutDown NOW! If you install ShutDown NOW! and enable it in Motherboard Monitor's setup, you will gain added protection for your system. If your CPU starts to overheat or if a fan fails, Motherboard Monitor can launch ShutDown NOW!, which will automatically shut down your PC and prevent damage. CPU Heat Up is another added utility, which can add a load to the processor if it starts to get cold enough to cause condensation from a peltier cooling system.

EnTech Taiwan PowerStrip 3.4
$29.95
www.entechtaiwan.com

PowerStrip is a utility designed specifically for graphics overclocking and other high-end video applications. However, it has some tools that make it useful for other types of overclocking, as well.

One of PowerStrip's main video functions is managing multimonitor displays. The utility supports many manufacturers' video cards and runs on Win9x/NT/Me/2000/XP. Other graphics-related features include color-correction tools, display settings, and gamma adjustments.

Motherboards With Great Utility

Many manufacturers include hardware-monitoring and overclocking utilities with their motherboards. The chart below summarizes some of the utilities motherboard manufacturers provide.

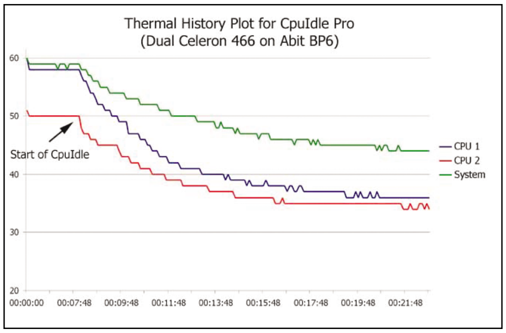
Company	Abit	AOpen		ASUS	Biostar	Chaintech
Web Site	www.abit-usa.com	english.aopen.com.tw		usa.asus.com	www.biostar.com.tw	www.chaintechusa.com
Name Of Software	uGuru	AOpen Hardware Monitoring Utility (also known as Integrated Technology Express' Smartguardian)	EZClock	ASUS PC Probe	WarpSpeeder	APOGEE Overclocking Utility
Features	OC NOW! (change BIOS settings without rebooting), save three BIOS settings to use for specific applications (such as gaming or burning CDs), Auto Reboot (automatically reboots if the overclocked settings don't work), Smart BIOS Flash (downloads and installs BIOS updates while leaving your BIOS settings intact), automatic system shut down to save components in case of hardware failure	Monitors CPU temp, system temp, fan speed, and voltages	Lets users adjust the voltage, FSB speed, and frequency of VGA, AGP, PCI, and DRAM. Also monitors fan speeds, voltages, and temperatures.	Tracks system temperatures, voltages, and fan speeds. Indicates information such as CPU type, CPU speed, and memory usage. Audio alarms sound if the temperature or voltage exceed user-defined limits.	Overclock Manager, Overvoltage Manager, and Hardware Manager	Lets users adjust voltage and FSB speed. APOGEE Overclocking Utility also monitors temperatures and fan speeds.

PowerStrip can also perform functions useful in general overclocking. For example, this utility can adjust clock speeds, making it a useful tool even for those who don't plan to tweak display settings, configure a multimonitor display, or overclock a graphics card.

PowerStrip's built-in diagnostic tools monitor the system and track Windows resource usage. The utility can work to improve the use of system memory. As many of the overclocking utilities do, PowerStrip includes a system-idle thread for versions of Windows that do not have built-in system-idle commands.

If your interests go beyond simple overclocking and into the video realm, you will find PowerStrip's many tools worthwhile. For example, the utility lets you configure hotkeys to adjust graphics settings. With the press of a button, you can adjust the gamma to lighten dark scenes in a first-person shooter and return to the default settings when your character returns to a well-lit room.

PowerStrip is a free trial download, and a single-user license costs $29.95. Make sure you visit EnTech Taiwan's site to download the correct PowerStrip application. A different company makes an IE toolbar called PowerStrip that is a completely different program. At press time, EnTech Taiwan had a 64-bit version of PowerStrip in beta testing.



This chart demonstrates how drastically system temps can drop when using CpuIdle.

GIMPS (Great Internet Mersenne Prime Search) Prime95 23.8
Freeware
mersenne.org/prime.htm

This well-known program doesn't actually aid directly in overclocking your system. However, system stability is one of the most important factors in overclocking a PC. If you want to test the stability of a system, installing Prime95 and forcing the PC to perform computations, searching for prime numbers is a great way to give your computer a workout.

Prime95 was designed for Intel-compatible PCs. However, several AMD processors have also handled Prime95's work just fine. When you use Prime95 to tax a system's resources and determine the stability after an overclock, you should let the software run for several hours, preferably at least six.

Leading Wintech Rain 2.0
Freeware
No active Web site (can download from www.majorgeeks.com, www.benchtest.com, and other sites)

Leading Wintech's Rain is another well-known name in the overclocking world. This program is no longer supported, and the manufacturer's Web site has been removed. You can still find many copies of Rain floating around the Internet, though, on sites such as www.majorgeeks.com and www.benchtest.com. Wintech Rain operates much like CpuIdle. Rain sends an HLT command to stop processor operations during idle times. This keeps overall system temps lower and reduces strain on the CPU.

Because Rain is an older program that is no longer supported, it is best for use with processors that are of the same era as Rain's last release. If you want to OC a Win9x/Me system with an older

EPoX	Gigabyte	Intel	Leadtek	MSI	Soltek		SuperMicro
web.epox.com	www.giga-byte.com	www.intel.com	www.leadtek.com	www.msicomputer.com	www.soltek.com.tw		www.supermicro.com
USDM (Unified System Diagnostic Manager)	EasyTune 4	Intel Active Monitor	Speed Gear	MSI PC Alert 4	Soltek Hardware Monitor	SmartDoc Anti-burning Shield	SuperO Doctor III
Monitors system temperatures, voltages, and fan speeds.	Monitors system temps and fan speeds and displays effective CPU speed. Lets users change the FSB speed, CPU multiplier, CPU voltage, AGP voltage, and memory voltage. Has Easy and Advanced settings to accommodate novice overclockers. Has warning alarms when fan speed or temperature gets too high.	Consumes less than 1% of system resources; tracks temps, voltages, and fan speeds; has failure notifications; and displays basic system information.	Monitors and displays basic system information, such as the processor speed, fan speed, and system temperature.	Monitors processor temperature, fan speeds, and voltages.	Tracks temperatures, voltages, and fan speeds.	Presents alarms when system's temps or voltages are too high. In extreme situations, will shut PC down within three seconds to avoid damage to components.	Software designed for managing servers, but it includes hardware, temperature, voltage, and fan monitoring.

processor, Rain could be the right utility for the job.

Remember when you use a program such as Rain that the processor only stops when it's idle. When you are using CPU-intensive applications, the processor will get just as warm as it would without Rain, so it's a good idea to have alternate cooling methods in place in addition to this utility.

SpeedFan

Freeware
www.almico.com

This is one of the utilities that is still updated frequently. At press time, the most recent update was released May 13, 2004. If you've used SpeedFan in the past but not recently, you may be pleased to learn that SpeedFan now supports NVIDIA video cards.

Almico's SpeedFan serves several roles. First, it uses sensor chips to monitor fan speeds, motherboard and processor temperatures, and voltages. Second, if your hard drive has SMART functionality, SpeedFan can access the SMART data and also monitor the hard drive temperature and generate SMART hard drive data reports. When used with a few select motherboards, SpeedFan can also alter the FSB, eliminating the need to first enter the BIOS.

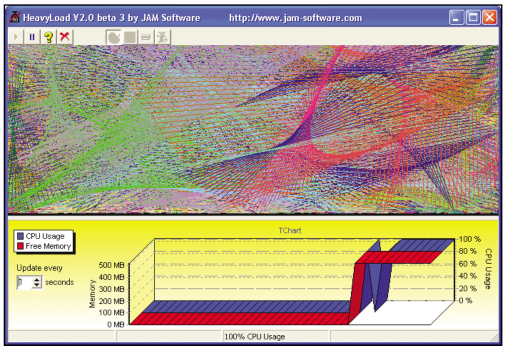
SpeedFan is not only compatible with a variety of chipsets and sensor chips, but it can also monitor several chips at once. It can also display a variety of temperatures from those devices, whereas some software can only display one temperature at a time. Similarly, SpeedFan can monitor multiple voltage and fan readings.

SpeedFan first monitors the temperature and voltage of various system components and then adjusts fan speeds according to your preferences to keep the system at the proper temperature, voltage, and performance levels. Alfredo Milani-Comparetti (who designed SpeedFan) suggests using a minimum fan speed of the highest value at which you hear no fan noise and using a maximum fan speed of 100. In order for SpeedFan to adjust fan speeds, however, you must have a compatible motherboard with compatible sensor chip. Check www.almico.com/forum index.php for the most recent list of supported hardware. SpeedFan is compatible with Win9x/NT/Me/2000/XP and Motherboard Monitor 5.

Vcool 1.7

Freeware
vcool.occludo.net

Vcool does the same thing many of the other utilities do in that it reduces the processor's power level when it's idle. However, Vcool is designed for a certain type of system and must therefore go about this task in a different way than other utilities do. Specifically, Vcool is for use with a system using an AMD processor and a motherboard with a VIA chipset.



Update every 1 seconds

100% CPU Usage

HeavyLoad places strain on the processor, as shown in the chart above. It uses a variety of resource-intensive tasks to push the CPU. One of these tasks is displaying the pattern shown in the top half of the window above.

According to Vcool's creator, AMD's Athlon and Duron processors can only enter a low-power state after the system bus is disconnected. Complicating matters, the VIA northbridge will not disconnect the bus unless the Bus Disconnect Enable bit is set and the processor is in a Stop Grant state. VCool sends the CPU into the Stop Grant state by issuing its own idle loop. Once the processor is in this state, the VIA northbridge can issue a bus disconnect, thereby putting the CPU in low-power mode.

In addition to lowering power usage, VCool shows the current processor temperature in the System Tray. You can also configure VCool to automatically slow the processor down if it gets too hot. VCool can also shut the system down if temperatures rise too far. VCool requires a system with Win98 or higher and a VIA VT8371, VT82C691/693A/694, or VT8363 northbridge and a VT82C686x southbridge.

Leading Wintech Waterfall Pro 2.9

Free
No Web site active (can download from www.majorgeeks.com, www.benchtest.com, and other sites)

Leading Wintech's Waterfall Pro 2.9 is a familiar name to those who have been overclocking for a while. Similar to the other programs that take advantage of CPU idle time, Waterfall executes HLT instructions to reduce power usage. The HLT instruction is executed in Ring 0 of the OS kernel, and according to Leading Wintech, no VxD is necessary to do this. Other programs such as CpuIdle use VxDs to execute the HLT command. Some systems will run better with Waterfall, others with a VxD-based utility.

Waterfall keeps a log of the CPU instructions and HLT commands. By clicking a Waterfall icon in the System Tray, you can access data about the percentage of commands that have been HLT commands, designed to cool the system and reduce power usage.

Only The Tip Of The Iceberg

Although we've presented six pages worth of overclocking utilities, we've barely begun to cover the programs that are available to help you push your system to the limit and ensure that your components, although overclocked and pushed to the maximum, will live to see another day. Installing overclocking utilities is one of the smartest things you can do when power modding because you can improve your overclocks and prevent damage to your system. Most of the overclocking utilities are bundled with motherboards, available as freeware, or priced very affordably as shareware. CPU

by Kylee Dickey

SIZING UP SOCKETS

How Your Processor Saddles Up

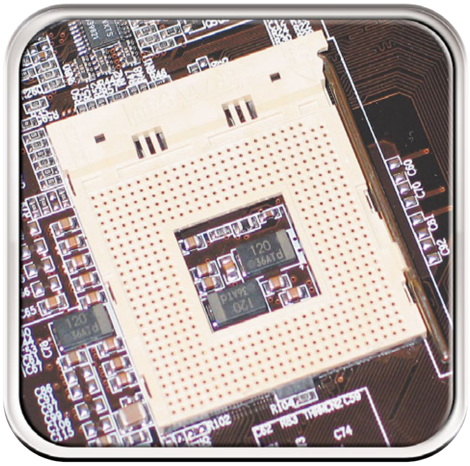
You may know your Athlon 64 FX-53's specs backward and forward, from its memory bus speed to its number of FPUs (floating point units). But that cowboy is going nowhere without his horse. Time to learn about the socket your processor rode in on.

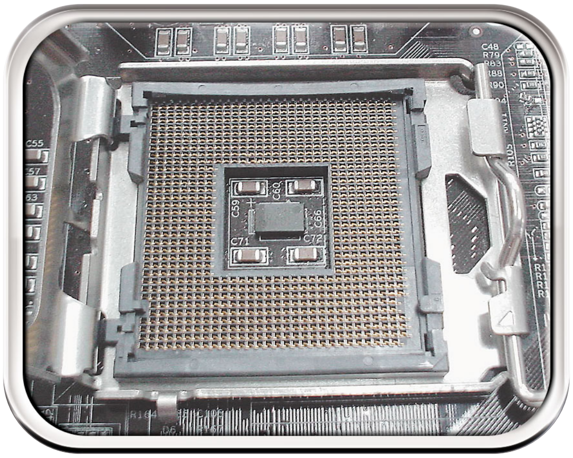
Here's a partial list of CPU sockets that are common today. Most are ZIF (zero insertion force) sockets, such as AMD's new 939-pin socket for the Athlon 64 and 64 FX. The tiny metal legs on the underside of a CPU's package, called a PGA (pin grid array), fit into holes in the socket. A lever on the side of a ZIF socket controls pressure on a PGA processor's legs, which holds them in place. To remove a CPU, pull the lever slightly to the side away from the socket and then lift it 90 degrees until it's pointing straight up from the motherboard. You can now lift out the processor and drop in a different one. Lock the new chip in place by reversing the steps above.

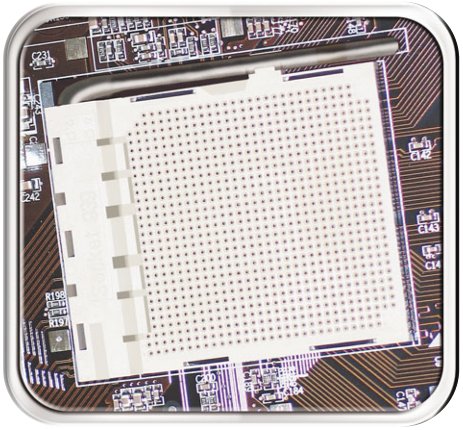
Intel's new LGA775 (land grid array) socket will wear the pins in the family, or rather slender contacts that resemble pins. The socket's 775 contacts correspond to lands, or conductive pads, on the Prescott Pentium 4's new package. A load plate holds the processor package against the socket under pressure to ensure that each land makes good contact.

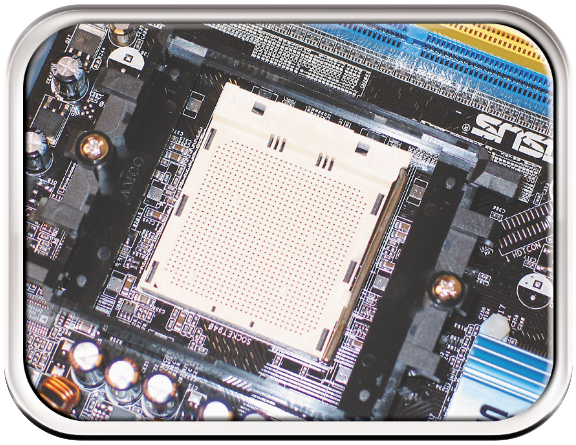
As a bonus, we've thrown in a few sockets for embedded processors, which are often soldered permanently in place and are not removable. These chips, mainly used in mobile devices, may have metal bumps called BGAs (ball grid arrays) instead of legs. CPU

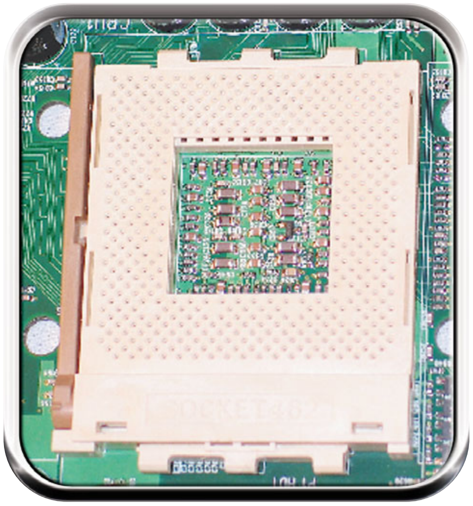
by Marty Sems


Socket 478

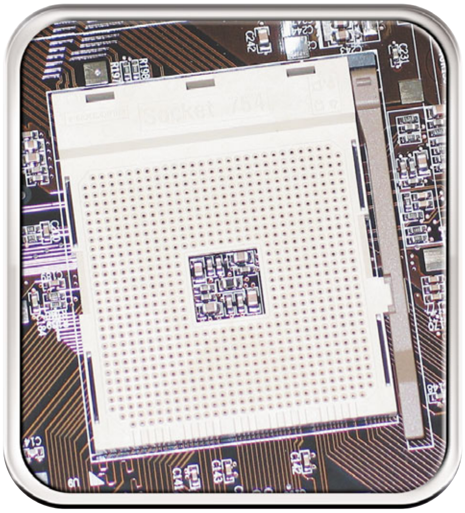

LGA775 Photo courtesy of Soltek.


Socket 939

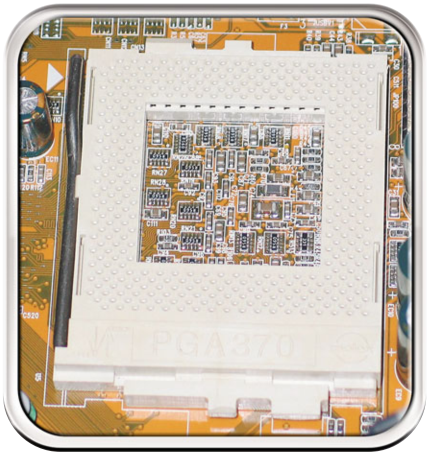

Socket 940



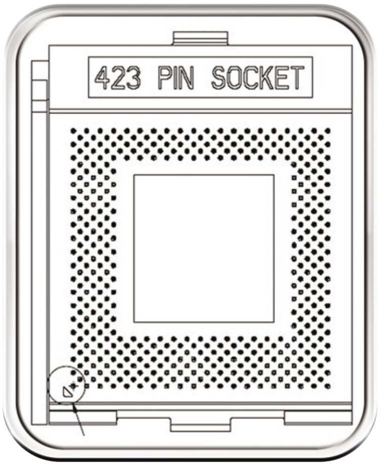
Socket 462



Socket 754



Socket 370



Socket 423

Diagram courtesy of Intel.

CPU Sockets

Desktop		Server		Mobile	
940-pin	AMD Athlon 64 FX (early)	940-pin	AMD Opteron	478-pin	Intel Pentium M, Mobile Pentium 4, Mobile Pentium 4-M, Celeron M, Mobile Celeron
754-pin	AMD Athlon 64 (early), Athlon XP (late)	611-pin	Intel Itanium 2	479-pin	Intel Pentium M, Mobile Pentium 4-M, Celeron M
478-pin	Intel Pentium 4 (including early Prescott core), P4 Extreme Edition, Celeron	418-pin	Intel Itanium	754-pin	AMD Athlon 64 for Notebooks
462-pin (Socket A)	AMD Athlon XP, Athlon (late), Duron	462-pin	AMD Athlon MP	462-pin	AMD Mobile Athlon XP/XP-M, Mobile Athlon 4, Mobile Duron
423-pin	Intel Pentium 4 (early)	603-pin	Intel Xeon, Xeon-MP	603-pin	Intel Mobile Pentium 4-M
775-contact (LGA775 [land grid array]; Socket T)	Intel Pentium 4 (later Prescott core)	604-pin	Intel Xeon	495-pin	Intel Mobile Celeron
939-pin	AMD Athlon 64 (late), Athlon 64 FX (late)	330-pin (slot)	Intel Xeon (early), Pentium III Xeon	474-ball	Transmeta Crusoe
370-pin	VIA C3, Eden, Antaur (CPGA), Intel Pentium III (late), Celeron	495-pin (slot)	Intel Pentium III Xeon	399-ball	Transmeta Crusoe
				783-ball	Transmeta Efficeon

THE MAD MODDER'S TOOLKIT

Minireviews, Meanderings & Musings

Once upon a Tuesday dreary, while I modded, weak and weary, over many a quaint and curious record by the band The Doors—while I tinkered, numbly singing, suddenly there came a pinging, as of someone gently ringing, ringing at my inbox door.

"'Tis some editor," I muttered, "Pinging at my inbox door—only this and nothing more."

"Do another Mad Modder's Toolkit," quoth my editor's email.

"Nevermore," I replied.

"Do it, you reclusive freak!" *[Editor—I don't really sound like that.]*

"Fine," I said. "But it will cost you."

First off, I resent being called "mad," although the pseudonym unfairly given me by *CPU* does allow me to live in peace, as opposed to inside a small, locked, lead-lined box in the clutches of my adversary soon after publication of my real name.

Secondly, just to show you what I had to put up with in the course of this assignment, I've left in selected revision notes from my editor. If Van Gogh had encountered editorial flak like this, he wouldn't have stopped with his ear, I can tell you.

And now, without further doodoo, this edition of Mad Modder's Toolkit, for which I demanded and received a full cask of Amontillado and a bust of Pallas. Readers of the previous issue will notice that I have included more actual tools in this Toolkit, 'cause no one expects you to do your best modding work with your fingernails. At least, you shouldn't have to in most countries.

If you're looking mostly for sexy blue lights and other fishing-lure stuff, you should flip to "Light My Fire" on page 176 in this issue. And on a personal note, guys who go around dating women named Lenore deserve what they get, anyway. CPU

by Mad Modder

Chicago Electric 180-Watt Industrial Soldering Gun
I paid: $9.99
Available at: www.harborfreight.com

There are a few modding tools you'll need besides that Dremel. You do have a Dremel, don't you? *[Ed.—Er, my girlfriend in Canada borrowed it.]*

Whether you're splicing wires or crimping them into connectors, you'll want to solder them for permanency. Nothing says "newb" like a case full of wire nuts and electrical tape.

This Harbor Freight house-brand gun comes with three tips, flux, and a teensy-tiny bit of rosin-core solder. There's even a replaceable lamp on the front behind a tough plastic lens. The users manual—highly detailed for a soldering iron, I might add—cautions that the tip can reach 1,135 degrees Fahrenheit. It goes on to warn you not to use the gun when tired or under the influence of drugs, alcohol, or medication. Yeah, like those aren't my periods of peak productivity.

Be sure to use solder with a decent silver content for the best conductivity, along with its recommended flux. Don't follow my example and just use whatever solder is handy. Let the twisted, fluxed wires heat the solder, not the gun tip. And don't let the molten metal wick past the twisted strands, or you'll make a stiff section that will weaken if bent.

Finally, don't forget to slip short lengths of heat-shrink tubing up each wire before soldering them. After you make each joint fast, slide the tubing down over it and shrink it with a heat gun or hair dryer. Easy. ▲

Asour VPC-1000 DVD Multimedia Audio Hub
I paid: $199.95
Available at: www.coolerguys.com

So what's keeping your computer from being a real entertainment appliance? That boot time, son. But here's a CD/MP3 disc player that's independently powered, so you can turn it on without even starting your PC.

What's more, the Hub is also a 16X DVD-ROM drive and an FM radio with SRS audio processing, EQ, and an IR remote. A flashy vacuum fluorescent display shows you where most of your money went. That display hinges downward to reveal the disc tray. Neat! (Never mind what a nice bookshelf stereo you could get for $200. Push it out of your mind.)

The downsides: You don't get any DVD playback software, and the max volume level may not be enough for some users with passive headphones. Also, one WinXP Home PC didn't recognize the drive, but another with WinXP Pro did. And would it have killed Asour to base the VPC-1000 on one of Samsung's excellent CD-RW/DVD-ROM combo drives for a few bucks more?

Ah, well. I'm nitpicking. Pop in a DVD of the first "Halloween," or maybe "Nightmare on Elm Street," and you're all set to mod. What, you're gonna tell me Freddy Krueger wasn't a DIYer? Look at those cool gloves he made, and he was even technically dead at the time. ▲

Cooler Master Musketeer LLC-U02
I paid: $36
Available at: www.cuttingedgecasemods.com

There's nothing musketeerish about this pretty drive bay gauge cluster, at least not in the military or literary senses. Maybe it's the three blue dials Cooler Master is referring to. Whatever, dawg.

Stuff the Musketeer into a drive bay. Run its thermal probe as near to your heatsink's center as you can get it and tape or thermal epoxy it in place. Now run your CPU fan's wires through the Musketeer so you can control the fan and view its voltage (from 6V to 9V in my unit), and thus a rough indication of its speed, on the left-hand dial. Next, patch in your sound card so you'll have a front volume control and a live VU meter, in theory.

Finally, whip a power supply connection into the back, and, well. . . . Unfortunately, the Musketeer's power connector dislodged from its circuit board as soon as I plugged a Molex 4-pin into it. I'm pretty sure it's not supposed to do that.

Furthermore, the VU meter and volume control only worked until I actually plugged a stereo headphone jack into them. When I give up a drive bay, a power lead, and a PCI slot, I'd like a bit more usefulness in return. Avoid. ▲

Black Powder Coated Case Handle
I paid: $15.95
Available at: www.voyeurmods.com

Any PC can be mobile if it has enough handles. This particular handle reminds me of the shipping cases I schlepped when I roadied for GWAR. Ahhh, Slymenstra, still you haunt me. *[Ed.—Did GWAR come before or after Slipknot? I get them confused.]*

This good-looking, spring-loaded handle is solid. It's stamped, but it's stamped from heavy-gauge steel, and all of its eight rivets are tightly set. The hard rubber grip had some molding flash, but I pared it away. And the durable finish reminds me: Check out the HotCoat powder coating kits at www.eastwoodco.com if you're looking for a tough alternative to paint or anodization for your mod case.

This should go without saying, but don't mount a handle like this in a panel that can't support the exertion. If in doubt, go ahead and install it. Then pick up your PC by the new handle and shake vigorously for a few minutes. *[Ed.—Really?]* No. Not really. ▲

Techflex Case Mod Expandable Wire Sleeving Kit UV Red #1903
I paid: $14.95
Available at: www.jab-tech.com
Connectorz Power Supply Changeover Kit Black Pro Series #2167
I paid: $9.95
Available at: www.jab-tech.com

Keep spaghetti where it belongs—in a can. *[Ed.—Philistine.]* A tangled mess o' wires in your PC not only looks bad, but it keeps air from circulating everywhere it needs to. It also makes simple R&R operations in the field harder than necessary. "Nurse! Clamp!"

Using TechFlex's UV red sleeving kit and Connectorz' p/s changeover kit, I was able to sleeve my power supply cables. The black, opaque Molex connectors made a nice counterpoint to the frilly, ultraviolet-reactive red sleeves in a paean to what too many newbs lack: a sense of taste. *[Ed.—Better put in a disclaimer against eating these, then.]*

Er, I was talking about restraint in adding colorful frou-frou, dear Editor, not literally the taste of the connectors. *[Ed.—Oh. Sorry.]*

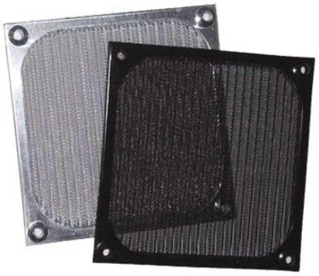
Which reminds me, dear Editor, of how little recognition you receive for all you do. Let me take this moment to paean you. *[Ed.—Wow! Thanks.]* ▲

80mm Aluminum Fan Filter Silver
I paid: $4.95
Available at: www.coolerguys.com

Dust! I hate dust. Fortunately, I hate cleaning even more, so I have lots of free time. That doesn't mean that I want my systems clogged with fuzz and dirt, which can heat things up, like in "The China Syndrome." A dirty case is even more unforgivable in a mod with transparent sections. Who wants to look at a scummy cold cathode?

I like to fit my intake fans with filters like these. They remind me of the grease hoods over the onion ring vats at one of my jobs I can talk about. Fan-style screws are included.

Just remember to hose these filters out every once in a while. Remove them from your case first, fool. ▲



Skil 4380 Orbital Cut Variable Speed Jigsaw
I paid: $39.99
Available at:
www.harborfreight.com

Sometimes, you just need to make a quick cut. And you don't have time to deal with dangerous gases, cosmic rays, or nasty smoke. A nice, variable-speed jigsaw like this one is what you need.

Toolless blade and foot angle changes make this chopper a pleasure to use, although the latter is limited to 90 and 45 degrees. The trigger lock is ambidextrous. There's a speed dial on the peak of the grip, which is inlaid with rubber and has a palm swell. Near the speed dial, my factory-reconditioned saw has the word "RECON" branded into it. Now I know what all those soldiers in Half-Life: Opposing Force were yelling about—they were supposed to be refurbishing everything, not shooting at me!

Anyway, think of the Skil 4380 as a B-movie spacecraft. Look in the place where you would expect rear photon torpedoes or seismic charges to pop out, and you'll find a trap door for spare blades. This appeals to the kid in me. Finally, there's a big lever on one side of the saw that makes the cutting action smooth (straight up and down) or orbital ("Back, and to the left! Back, and to the left!").

Drill a pilot hole before you cut, and you're off. Use metal-cutting blades of the right type, such as T or U, and stick to higher tooth per inch counts, such as 24tpi or 32tpi. And if you put some tape down before you cut, you'll spare your case a lot of scratches.

Remember, modding is about building things. The nihilistic fun of chopping and gouging is just a side benefit. ▲

Craftsman 7 pc. Magnetic Screwdriver Set
I paid: $9.99
Available at: www.sears.com

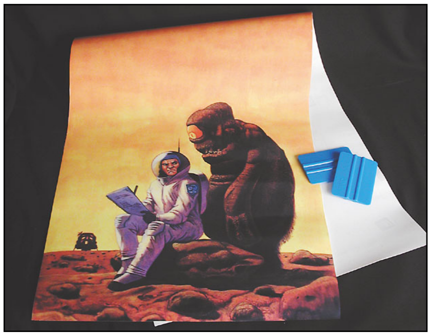
OK, so Craftsman is not my favorite brand for anything but hand tools. After problems with a Craftsman air compressor (no interior rust protection and L-O-U-D), garage door opener (fragile plastic drive gears), and lawn mower (hard-starting, non-adjustable carburetor), I feel justified in my bitterness. You don't have to kick me in the head a fourth time. Sears may be coasting on the Craftsman name and the exorbitant prices it brings, but boy, do they make good inert metal objects.

I once shunned magnetic-tip screwdrivers around computer equipment, but that was before dropping my nine millionth tiny bolt into an inaccessible case recess. And forget those ratchet-style, pseudoergonomic screwdrivers; they're utter crap when you're working with computers. Very few bolts in your PC turn with enough friction to overcome the screwdriver's ratchet mechanism, so you'll wind up holding the shaft with your fingers as you crank with the other hand. A regular screwdriver is faster—but a cordless, variable-speed model is faster yet. ▲

PolyGFX No Peace Case Skin
I paid: $59.99
Available at: www.frozencpu.com

Want a custom paint job on your tower without the custom price tag? Skin it. Send FrozenCPU.com the dimensions of your case as illustrated on the site, then sit back and wait for your adhesive design to arrive. When it does, clean your case, stick on the skin, and start a-trimmin'.

If you have fans, windows, or latches on your case's side panels, try to choose a design with a focal point that won't be lost when you cut out those sections. Skins are available for various tastes, and they ain't all politically correct. Some are delightfully tacky, in a beyond-Lara Croft sort of way, and practically guaranteed to drive away potential girlfriends.



Heh. "No Peace" reminds me of the pre-Altamont era, sort of. "No hummus, no peas!" Or something like that. I was too busy whispering rhetoric in the ears of very, very earnest girls in berets. I fervently believed whatever the girl with me at the time believed, which meant that I enjoyed the decade more than most. *[Ed.—Back on topic, please.]* ▲

Hypertherm Powermax380 Plasma Cutter
I paid: $999
Available at: www.harrisweldingsupplies.com
www.hypertherm.com/company/north_america.htm

Solids. Liquids. Gases. Most people, sadly, are satisfied with control over just three states of matter. You, however are not most people. You are a modder—unless you are yet another minion of my arch-nemesis, in which case I should warn you that you are in no way being paid enough to take me on. I am ready for you. *[Ed.—Whatever you're taking for your paranoia, MM, up the dosage.]*

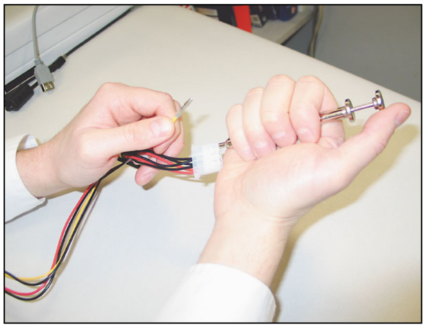
A plasma cutter, such as this very nice example from Hypertherm, uses your filtered compressed air and a whole lotta electricity to create a fourth state of matter, plasma, which in this case happens to be hotter than some neighborhoods on the sun. Plasma slices anything metallic—mild steel, aluminum, titanium—like so much warm butter. Complex window shapes and blowholes await. Hint: Use the edge of something to guide your nozzle.

This model comes set up for 115V, but you'll want to flip the switch and replace the plug for 230V operation for best results. Don't forget your welding mask and gloves. And if you're muttering to yourself about how a jigsaw can do almost the same thing for 5% of the cost, I must question your dedication to the art. Modding is all about fun, is it not? I posit that there are few things more fun than blowing slag at 8,500 degrees Fahrenheit. *[Ed.—Uh, back to Earth, please.]* ▲

ConnectRight Universal Molex Pin Remover
I paid: $9.99
Available at:
www.frozencpu.com

It never fails to amaze me how difficult it is to take a Molex power connector apart without hurting it. You should have more options than smashing or snipping, in my opinion. Now you do, thanks to this handy tool.

It looks like a blackhead remover for robots, but it's not. *[Ed.—Eww.]* As my editor is demonstrating in the photo, you slip the sleeve tip into the connector, then hold both tightly as you push on the spring-loaded plunger. This makes adding UV-sensitive or color-coordinated connectors a cinch.



Actually, my sample made working with female, full-sized, 4-pin Molex connectors a cinch. The tip plunger didn't retract enough to accommodate male connector pins, which led me to suspect that I'd received the Female Molex Pin Remover instead of the Universal jobby I ordered. Anyway, the Remover's tip is also too fat to help you with floppy drive, fan, or motherboard power connectors, but ConnectRight does sell other pin removers that cover some of these bases. ▲

RD3XP-A32-K Gladiator 18" EMI Shielded Server Grade ATA Cable (Two Device)
I paid: $19.99
Available at: www.highspeedpc.com
www.hardwarecooling.com

Back when we used to roll our own rounded cables, we worried a little bit about crosstalk between wires. (Actually, some of my ex-associates worried more about crosstalk from mothership to skull, if you follow me. Ever watch a nervous type try to camouflage his shiny foil helmet from imaginary black helicopters? Entertainment is where you find it.)

Anyway, this EIDE cable offers individual aluminum shielding for each wire, plus a grounding strap. The upshot is supposed to be fewer data errors from EMI and crosstalk, and hence faster data transfers. Vendor IOSS/VICS Technology claims that independent tests showed a 10dB noise reduction for this cable over a regular ATA/133 ribbon cable. And it sure looks serious. ▲

Mouse Bungee
I paid: $9.95
Available at: www.mousebungee.com

They may call me mad, but I ain't crazy. I will use no mouse before it's Bungeed. When I am asserting my dominance over twitch-happy wannabes in a fragfest, I do not want the distracting resistance of my mouse cord rubbing on the back corner of my work surface.

The genius of the often-imitated, never-duplicated Mouse Bungee is that it holds the tail of your wrist weasel a few inches off the desk to avoid entanglement in the usual kipple. Dual springs offer just the right amount of give when, in its excitement, your palm rodent moves beyond the slack in its leash.

The Mouse Bungee's base has skid-resistant feet (paws?) and a polished metal weight, so it's not going to skitter around your desk unless you get really frisky. That weight could even make a formidable slingshot missile in a survival situation, although you'd have to break the Bungee to get at it. For less dire scenarios, I recommend practicing a basic overhead swinging maneuver while you're still holding onto the mouse. A sharp crack with a Bungee at velocity might slow or stop a moderately determined attacker, even if you're taken by surprise. *[Ed.—Please get back to reviewing this product.]*

In the end, a Mouse Bungee is a cheap way to alleviate the frustrations typically attendant in a finger ferret. And there's even an Unreal Tournament 2004 version. Recommended. ▲

Thermaltake Hardcano 12

I paid: $64.95
Available at: www.crazypc.com
www.coolerguys.com

Here's a bay-mount fan and temperature controller that looks like a car stereo. It has four temp probes and leads for four fans, plus automatic fan speed control based on temperature, so it's much more useful than the Musketeer in this article. Its LCD is backlit in blue.

Now the bad news. The Hardcano 12 does not act as a hard drive cooler as some online retailers claim. Even Thermaltake categorizes it in its Hard Disk Drive Cooler Series. I feel a bit cheated. Also, one of the temp probes wasn't connected internally, and another didn't work at all.

Finally, the Hardcano's bezel and buttons feel chintzy. Press one button, and the rest wobble around. Still, the controls are intuitive and the thing does work, mostly. ▲

Hobart Handler 135 MIG Welder

I paid: $499
Available at:
www.harborfreight.com
www.sears.com

What you would tear asunder, you must also be able to rejoin. And nothing joins sheet metal like a MIG (metal inert gas) welder.

With a bit of practice, you'll be able to do some amazing things to your mod PC's case. How about a custom air scoop on the top instead of a blowhole, sucking cool air like the Weiand blower in "Mad Max"? How about a jet exhaust afterburner on the back, lighted with a red cold-cathode tube that brightens as the dynamic fan speed revs up?

The best part about a MIG is that you can swap gas cylinders and wire spools to weld different metals, so you can tackle your Lian-Li aluminum case or a stainless steel DeLorean fender as easily as your cheap steel tower. Just think what some custom aluminum brackets or hinged panels could do for your silver streak.

Figure on about $175 for a big, refillable gas cylinder of 75% argon/25% CO2 for mild steel; smaller units are available. And if you skip your welding helmet and fry your eyeballs out, don't come crying to me. *[Ed.—I'm not sure if that counts as a legal disclaimer.]* ▲

Radiant Ellipse Top Window Kit, 80mm Fan Hole

I paid: $17
Available at: www.cuttingedgecasemods.com

Sometimes time is short. Sometimes your heart isn't in it. Sometimes you just want to do a quick mod, not a work of art.

At times like these, there's no shame in installing a slick, prefab kit like this one. It's precut, it looks good, and it won't suck up your whole weekend. You know in your heart that you could have done better making one from scratch, anyway.

This new "Radiant" acrylic is kind of neat. It's reflective, like a gold-tinted mirror, until lighted from behind. I bought it along with a red cold-cathode 80mm sleeve fan ($10; 31cfm/28dB/2,700rpm) and an old-school atom symbol fan grill ($4.49) from Cuttingedgecasemods.com. It's gonna look right at home above that No Peace case skin, kind of comic-retro. Dig it. ▲

SILICON MEETS SILICON

Our Overclocking Series On Chip & Chipset Combos

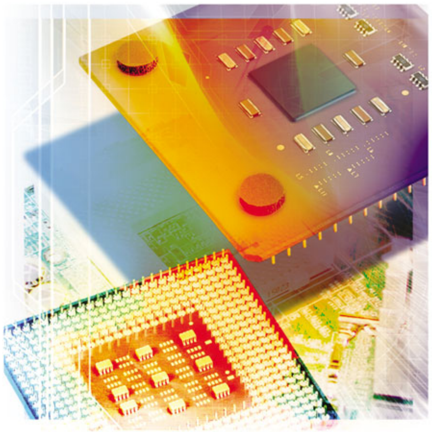
It doesn't seem like much time has passed since we put out our first *PC Modder*. Not all that long ago, we were cranking up FSB speeds and churning out articles with more numbers per page than your local phone book. Maybe only a few months have gone by since our last issue, but a lot has changed in the computing world. AMD has continued its foray into 64-bit desktop computing while Intel has finally rolled out Pentium 4 processors based on its 90nm Prescott core. It's time to find out just how far we can push the latest crop of processors.

We've made a few changes in this section from our first *PC Modder* issue. When it comes to overclocking, the chipset you use is as important as the processor. Rather than pair one processor with one motherboard as we did last time, in this issue we've paired each of our eight different processors with three different motherboards, each sporting a different chipset. This approach should provide a better look at how well processors perform on different motherboard chipsets and gives us the opportunity to look at offerings from a larger number of motherboard manufacturers.

Test Systems

In response to reader requests, we've made our test systems for both Intel and AMD pairings as similar as possible. Our main purpose in writing each case study is to show what kind of performance you can expect from overclocking certain motherboard/processor combinations. That said, using similar test systems should allow those of you who want to directly compare Intel and AMD performance a more solid foundation on which to do so.

Both systems use a Gainward PowerPack! Ultra/1800 XP Golden Sample, NVIDIA GeForce FX 5950 Ultra video card, and two 512MB PC4000 DDR SDRAM modules. Using two memory modules will give a slight leg up to systems that can take advantage of dual-channel memory. For storage, we used an 80GB Western Digital WD800JD 7,200rpm SATA hard drive along with a LiteOn Black 48X/24X/48X/16X DVD/CD-RW combo drive and a Samsung 1.44MB floppy drive. We housed both systems in an identical Antec PLUS1080AMG case that included a 430W TruePower PSU. Finally, we included a Digital Doc in each case to record temperatures. We taped a processor probe to the motherboard so that it was touching a corner of the processor and a second probe was left dangling near the front of the case to measure ambient heat.



We relied strictly on aircooling for these articles. We used a Thermalright SLK-948U copper heatsink and a 4,800rpm pcToys 92mm Tornado fan that can move a breezy 119CFM. Granted, that nice 119CFM comes at a rather loud 56.4dB, and I don't think the labs guys cared too much for our choice in fans, but our combination seemed to do the job much better than a stock heatsink/fan.

Testing

What good is it to brag about squeezing an extra 500MHz out of a processor if it doesn't provide any real gains in performance? Each time we inched the clock speed higher, we used FutureMark's 3Dmark03 to gauge any real performance increase. We also found 3Dmark03 to be an excellent test of the system's overall stability at higher clock speeds. Heat measurements were also recorded during 3Dmark03 near the end of CPU Test No. 1.

PCMark04 let us test individual system components. PCMark04 provides an overall system score along with individual scores for the processor, memory, graphics card, and hard drive. PCMark04 also provides some insight into how overclocking the system affects different components.

We benchmarked each system with its default settings to get solid baseline scores for both 3Dmark03 and PCMark04. We then increased the motherboard's frontside bus and ran 3Dmark03 to gauge the system's stability. If the system completed 3Dmark03, we increased the FSB and retested. We continued this process until the system was unable to complete 3Dmark03 or refused to boot. Once we found the fastest possible clock speed, we ran PCMark04 to see how overclocking affected various system components.

On select systems we were able to adjust the clock multiplier, which complicated testing a bit. In these situations we began by adjusting the FSB as described above. After achieving the highest possible clock speed, we reset all settings to their default and began adjusting the clock multiplier. Again, after achieving the highest possible clock speed and recording our benchmark scores, we returned the system to its default settings and began adjusting both the FSB and clock multiplier.

Finally, we want to extend a special thanks to our lab crew—Coby Boring, Chad Dalton, Andy Gerace, and Jeff Roberts—for all the extra hours they spent assembling and testing our systems. We also want to thank Kevin Morgan who ordered and tracked an insane amount of hardware for this issue. CPU

by Chad Denton

3.0E GHz PENTIUM 4 & BIOSTAR P4TSV (INTEL 865G)

After several delays, Intel has finally shipped its new Pentium 4 core (you probably know it as Prescott). Among Prescott's new features are smaller 90nm transistors, a new, strained silicon design, and a longer data pipeline. While these additions give Intel more headroom to ramp up clock speeds, they also cause a few problems. The combination of Prescott's strained silicon design, smaller transistors, and increased core voltage means more energy leakage, which manifests itself as heat. The longer pipeline also tends to slow overall performance. As a result, older Northwood chips are faster clock per clock than today's Prescott chips. As Prescott's speed increases, however, performance should become more impressive.

Current Prescott chips are running at the same speeds as existing Northwood chips, so there's little incentive for the casual user to choose Prescott over more readily available and less expensive Northwood cores. Prescott, however, may be of interest to overclockers, as it should provide more headroom to increase clock speeds.

Motherboard

We started off our test of Intel's 3GHz Prescott chip with a Biostar P4TSV motherboard. The P4TSV uses the 865G variant of Intel's Springdale chipset family. Both the 865G and 865PE chipsets support a quad-pumped 800MHz FSB, but the 865G includes an Intel Extreme Graphics 2 video chipset. Naturally, we opted for our NVIDIA card instead of the integrated Intel chip. Like most motherboards, the P4TSV includes integrated Ethernet and audio controllers. The C-Media CMI9739A provides 6-channel audio and S/PDIF out while the RealTek RTL8100B supports 10/100 Ethernet (no Gigabit Ethernet on this board).

The 865G supports up to 4GB of dual-channel DDR SDRAM (PC2700 or PC3200). Our Mushkin PC4000 DDR memory is, of course, compatible; it will just run at PC3200 speed.

Biostar pairs the 865G on the northbridge with Intel's ICH5 on the southbridge. The ICH5 supports up to eight USB 2.0 ports and dual SATA connectors but lacks RAID support.

The P4TSV is a compact motherboard with little room for expansion slots. You'll find just three PCI slots in addition to one AGP and one CNR slot. The lack of expansion cards may force you to consider using the onboard audio and LAN chips rather than installing separate cards for each (which would leave you with just one remaining PCI slot).

Overclocking

Before we start turning up the FSB, we needed a solid set of baseline test scores under the system's default configuration. The system's default settings left the FSB set at 200MHz which, combined with the processor's 15X clock multiplier, resulted in a 3GHz clock speed. CPU VCore Voltage was left at the default 1.35 volts. At these settings our Prescott Pentium 4 managed a 6530 3Dmark03 score. CPU temperature as reported by our temperature probe was 38.7 degrees Celsius and the ambient case temp was 29.7 degrees Celsius. The overall PCMark04 score was 4829. Individual PCMark04 component scores for our default configuration consisted of a 4611 Processor score, 4914 Memory score, 5384 Graphics score, and a 4243 HDD score.

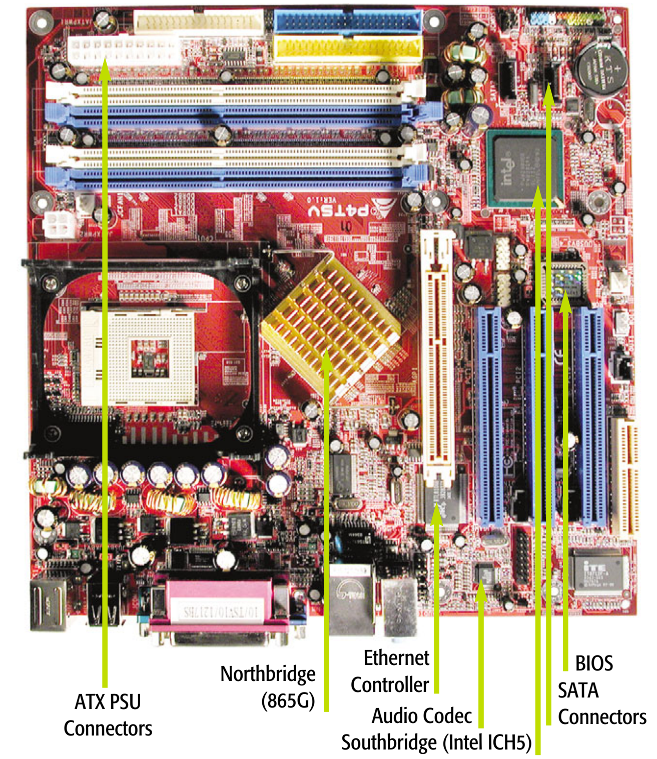
System Specs

Processor, Motherboard & Drivers	
Processor	3.0E GHz Pentium 4 (Prescott)
Motherboard	Biostar P4TSV
BIOS Manufacturer	Phoenix
BIOS Version	6.00 PG
Chipset Driver	5.00.101.2
Common Components	
RAM	DDR SDRAM (2 x 512MB)
Video	Gainward PowerPack! Ultra/1800 XP Golden Sample (GeForce FX 5950 Ultra)
Hard Drive	80GB Western Digital WD800JD 7,200rpm SATA
Heatsink	Thermalright SLK-948U
CPU Fan	pcToys 92mm Tornado
CD-ROM	LiteOn Black 48x24x48x16 DVD/CD-RW
Floppy	Samsung 1.44MB
Power Supply	Antec 430W TruePower
Case	Antec PLUS1080AMG
Temperature Monitor	MacPower Digital Doc 5

3.0E GHz Pentium 4 Biostar P4TSV 865G

	Processor Speed	FSB	Multiplier	Voltage	Processor Temp	Case Temp	3Dmark03	PCMark04	PCMark04 CPU	PCMark04 Memory	PCMark04 Graphics	PCMark04 HDD
Stock Performance	3.00GHz	200MHz	15	1.35	38.7	29.7	6530	4829	4611	4914	5384	4243
Overclocked Performance	3.39GHz	225MHz	15	1.35	41.9	31.4	6687	5358	5135	5547	5513	4242

After completing our initial benches, we entered the system's setup utility by pressing the DEL key during POST. The P4TSV lacks some of the more advanced overclocking features found on other motherboards. For instance, we couldn't lock the AGP and PCI buses. This, perhaps, may have led to instability at lower clock speeds compared to the other two boards we tested with the 3.0E GHz P4.

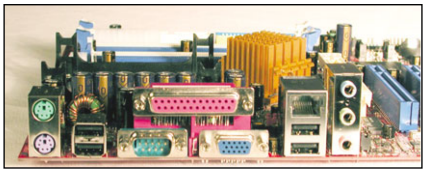


From the main menu, we selected Frequency/Voltage Control. We then selected CPU Clock and used PAGE UP and PAGE DOWN to adjust the frontside bus from its default value of 200MHz to 210MHz, resulting in a 3.15GHz CPU clock. The increased clock speed amounted to a 76-point gain in 3Dmark03. We returned to the Frequency/Voltage Control menu and increased the FSB to 220MHz (3.31GHz CPU clock). Once again we saw solid improvements in 3Dmark03, as scores rose 53 points to 6659.

Trying to increase the FSB to 230MHz (3.45GHz) prevented the system from booting. We returned to the setup utility and decreased the FSB to 225MHz (a CPU clock speed of 3.39GHz). This time, the system booted properly and completed 3Dmark03. 3Dmark03 scores show a more modest improvement of just 28 points, but that's not bad considering the CPU's clock speed increased just 80MHz.

In an attempt to zero in on the absolute highest clock speed, we tried an FSB of 227MHz. When the system failed to boot, we adjusted the FSB down to 226MHz, but the system still refused to boot.

In an effort to make the processor more stable, we increased the CPU Voltage in the Frequency/Voltage Control menu. The P4TSV lets you adjust the CPU voltage as a percentage of the default voltage. We used the PAGE UP and PAGE DOWN keys to set the CPU Voltage to +2.5%. This resulted in a CPU voltage of 1.4V. We reset the FSB to 220MHz (3.31GHz CPU clock) and received a 6661 3Dmark03 score (2 points higher than the previous score at 3.31GHz). The added voltage, however, also added plenty of heat. The 43.4-degrees processor temp was 4.4 degrees higher than it was previously at 3.31GHz, and the ambient case temp increased 1.9 degrees to 31.7 degrees.



We increased the FSB to 225MHz, which put the processor's clock speed back at 3.39GHz. This time, the 6682 3Dmark03 score was slightly lower than it was previously at 3.39GHz.

The higher CPU voltage did little to stabilize the system at clock speeds faster than 225MHz, however. The system refused to boot at 227MHz and 226MHz, respectively. We adjusted the CPU Voltage to +5.5%, resulting in a CPU voltage of approximately 1.45V, and we reset the FSB to 220MHz.

3Dmark03 scores were roughly the same as previous attempts at 3.31GHz. This time we proceeded a bit more cautiously and increased the FSB 3MHz to 223MHz, resulting in a 6679 3Dmark03 score. Attempts to increase the FSB beyond 223MHz at 1.45V, however, caused Windows to lock up. Increasing the CPU voltage to 1.5V allowed us to get scores at 223MHz and 224MHz, but we couldn't quite get the FSB up to 225MHz again without the system crashing. At 1.5V and a 224MHz FSB, the processor temperature maxed out at 48 degrees and the ambient case temperature hit 31.3 degrees. Undoubtedly, temps were even higher at the CPU's core.

Overclock Comparison 3Dmark03

ABIT AI7	
Stock Performance	6539
Overclocked Performance	6726
EPoX EP-4PCA3+	
Stock Performance	6535
Overclocked Performance	6721
★ Biostar P4TSV	
Stock Performance	6530
Overclocked Performance	6687

Seeing as how we achieved our best 3Dmark03 score with the default 1.35V, we reduced the CPU voltage to its default and set the FSB back to 225MHz. We then ran PCMark04 to gauge how the system's components were handling the added speed. The overall PCMark04 score increased more than 500 points to 5358 with nearly all components showing an impressive increase. The largest increase for any single component was the Memory score, which jumped from 4914 to 5547, an increase of more than 600 points. The Processor score increased more than 500 points from 4611 to 5135 and Graphics increased more than 100 points from 5384 to 5513. The HDD score remained virtually unchanged at 4242.

Final Word

After our initial testing with the P4TSV, the 3GHz Prescott seems to have more headroom for overclocking than its Northwood sibling. By way of comparison, we were only able to get the 3GHz Northwood up to 3.23GHz on the ASUS P4C800 Canterwood motherboard. The P4TSV, however, didn't allow us to lock down the PCI or AGP bus when increasing the FSB, which could've led to more stability in the system. We'll see whether or not we can push the 3GHz Prescott further in the next couple of case studies.

by Chad Denton

3.0E GHz Pentium 4 & ABIT AI7

We got a glimpse of what the Pentium 4's new Prescott core is capable of in the previous case study. On a modest Biostar P4TSV using Intel's 865G chipset, we were able to increase the clock speed on our 3.0E GHz Pentium 4 to 3.39GHz. Now it's time to see how well the processor performs on a high-end ABIT board with an Intel 865PE chipset.

Motherboard

This time, we'll be running our 3.0 E GHz Prescott on an ABIT AI7. The ABIT board does a better job of targeting the enthusiast crowd and catering to overclockers. Instead of the Intel 865G, the AI7 relies on the Intel 865PE chipset. The major difference between the two chipsets is that the 865PE lacks an integrated video chip. On the surface, this may seem to be an advantage for the 865G, but few enthusiasts are going to settle for Intel's integrated graphics chip. As a result, most 865G boards are aimed at a lower segment of the market.

Intel considers the 865PE to be a mid-level chipset but it's actually quite popular with enthusiasts because it provides excellent performance for the price. Like Intel's high-end 875P chipset, the 865PE supports an 800MHz FSB and dual-channel memory. Intel's PAT (Performance Acceleration Technology) comes enabled by default on 875P chipsets. According to Intel, PAT reduces memory latency by as much as two clock cycles when used with PC3200 DDR SDRAM. As you'll see in the next case study, however, PAT may not always be worth the premium price you pay for most 875P motherboards, especially considering some manufacturers enable PAT on 865PE motherboards. Intel, however, warns that enabling PAT on 865PE motherboards could damage the chipset or lead to stability issues.

As we mentioned, the AI7 is one of the more expensive 865PE motherboards. One reason for the AI7's higher price is the ICH5R southbridge chipset. As you can probably guess, the "R" stands for "RAID" and the ICH5R supports both RAID 0 (stripping) and RAID 1 (mirroring).

As we've come to expect from most motherboards, the ABIT AI7 does come with integrated audio and Ethernet. A Realtek ALC658 chip provides integrated six-channel audio, automatic jack sensing, and SPDIF output. An additional Realtek Ethernet controller provides integrated 10/100 Ethernet connectivity. The AI7 supports eight USB 2.0 ports and three FireWire ports.

Unlike the earlier Biostar board, the AI7 also features more room for expansion. In addition to the requisite AGP slot, the AI7 features five PCI slots that should provide adequate expansion options even if you have to install PCI-based replacements for the integrated audio and sound.

Overclocking

Before we started messing around with the BIOS settings, we took some baseline 3Dmark03 and PCMark04 scores. While the 6539 3Dmark03 score was 9points better than the P4TSV managed at 3GHz, some PCMark04 scores were down slightly. The overall PCMark04 score fell from 4829 in the previous case study to 4823. The PCMark04 CPU score fell from 4611 to 4587. Other PCMark04 scores, however, were a little better than the baseline scores posted by P4TSV. The Memory score increased from 4914 to 4931, the Graphics score increased from 5384 to 5408, and the HDD score increased from 4243 to 4296. When idle, our 3.0E GHz Prescott's temperature was 33.3 degrees Celsius, about 0.6 C cooler than it was on the P4TSV board. The AI7, however, provides a slightly higher current (1.385V compared to 1.35V) and the processor proved slightly warmer under load. On the AI7, our Prescott's temperature reached 40.6 C, about 1.9 C warmer than the initial

System Specs

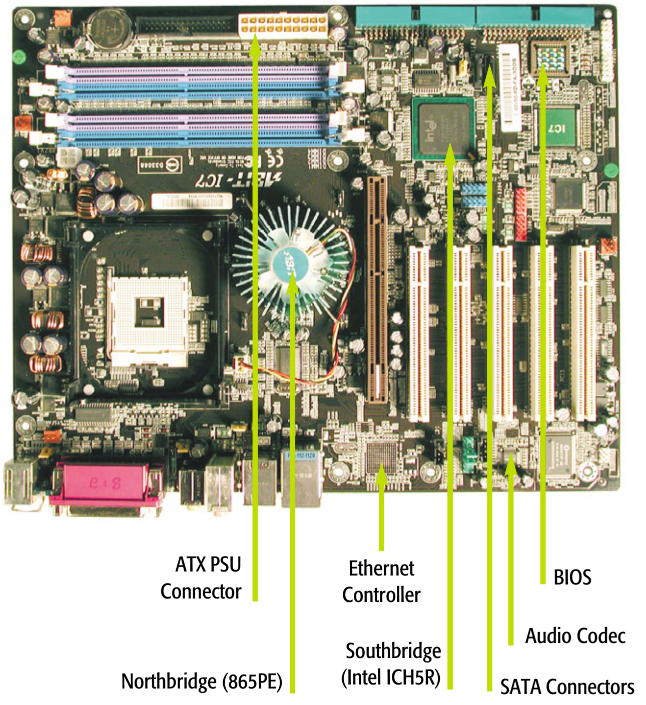
Processor, Motherboard & Drivers	
Processor	3.0E GHz Pentium 4 (Prescott)
Motherboard	ABIT AI7
BIOS Manufacturer	Phoenix
BIOS Version	13
Chipset Driver	5.02.1003
Common Components	
RAM	DDR SDRAM (2 x 512MB)
Video	Gainward PowerPack! Ultra/1800 XP Golden Sample (GeForce FX 5950 Ultra)
Hard Drive	80GB Western Digital WD800JD 7,200rpm SATA
Heatsink	Thermalright SLK-948U
CPU Fan	pcToys 92mm Tornado
CD-ROM	LiteOn Black 48X/24X/48X/16X DVD/CD-RW
Floppy	Samsung 1.44MB
Power Supply	Antec 430W TruePower
Case	Antec PLUS1080AMG
Temperature Monitor	MacPower Digital Doc 5

3.0E GHz Pentium 4 ABIT AI7

	Processor Speed	FSB	Multiplier	Voltage	Processor Temp	Case Temp	3Dmark03	PCMark04	PCMark04 CPU	PCMark04 Memory	PCMark04 Graphics	PCMark04 HDD
Stock Performance	3GHz	200MHz	15	1.3875	40.6	30.5	6539	4823	4587	4931	5408	4296
Overclocked Performance	3.46GHz	230MHz	15	1.6125	44.2	30.7	6726	5499	5257	5659	5563	4312

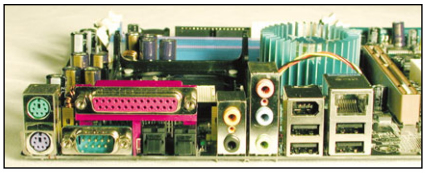
load temperature in our last case study. Under load, the ambient case temperature reached 30.5 C.

After recording our initial scores, we accessed the system's setup utility by pressing DEL during POST. Overclocking options were found in the SoftMenu Setup section. We increased the FSB by highlighting CPU Operating Speed and using PAGE UP and PAGE DOWN to adjust the value to 210MHz (you can probably argue that this item is mislabeled since it measures the FSB rather than the processor's clock speed). We then saved the settings and exited the Setup utility. After rebooting we had turned our 3GHz processor into a 3.16GHz P4. The increased speed added 60 points to our 3Dmark03 score. This was actually 7 points lower than the 6606 score we managed on the P4TSV at this speed.



We increased the clock speed another 10MHz to 220MHz, resulting in a 3.30GHz P4. Once again, the speed boost netted a significant 3Dmark03 improvement. Scores rose to 6663, which was just slightly better than the P4TSV managed at this speed. The P4TSV only allowed us to increase the FSB speed to 225MHz before the system refused to boot. We increased the AI7 to 230MHz to see what would happen and were delighted to learn the AI7 ran reliably at 230MHz. The resulting 3.46GHz P4 ran perfectly and managed to complete 3Dmark03 with a 6697 score.

Increasing the FSB another 10MHz prevented the system from even booting. We decided to taper our ambitions a bit and reduce the clock speed to 235MHz. When the system still refused to boot, we decreased the clock speed to 232MHz and this time the system booted properly, but 3Dmark03 crashed midtest, suggesting the system wasn't entirely stable. We decreased the FSB again to 231MHz, but 3Dmark03 was still unsuccessful. We returned our system to 230MHz and increased the processor's core voltage by selecting CPU Power Supply in the SoftMenu Setup section of the setup utility. We used PAGE UP to select User Defined and then adjusted the CPU Core Voltage to 1.4375V. The extra power actually seemed to make things worse as 3Dmark03 crashed at 230MHz. We increased the core voltage once again to 1.5125V. This increase resulted in improved stability and a better 3Dmark03 score of 6717.



We increased the FSB to 232MHz, but once again the benchmark crashed on us. We left the FSB at 232MHz and increased the voltage to 1.6125V, but still couldn't get the system to complete 3Dmark03. Decreasing the FSB to 231MHz didn't help our stability problems. We had some concerns that the 1.6125V core voltage might be a little high, so we left the core voltage intact and reduced the FSB to 230MHz. The system was not only still reliable at 230MHz, but it yielded a 6726 3Dmark03 score, the highest score we had yet received.

Increasing the processor's voltage further didn't allow us to push FSB speeds any higher. We reset the core voltage to 1.6125V and the FSB to 230MHz to run PCMark04. The overall PCMark04 score increased significantly from 4823 to 5499. The CPU score itself increased almost 700 points to 5257 while the Memory score increased more than 700 points to 5659. The Graphics score showed the least improvement but still went up more than 150 points to 5563. The HDD score, typically, showed little improvement at 4312.

Overclock Comparison 3Dmark03

★ ABIT AI7	
Stock Performance	6539
Overclocked Performance	6726
EPoX EP-4PCA3+	
Stock Performance	6535
Overclocked Performance	6721
Biostar P4TSV	
Stock Performance	6530
Overclocked Performance	6687

Final Word

Looking at the Biostar P4TSV and the ABIT AI7, you can see why we wanted to run the same processor on multiple motherboards. The ABIT AI7 proved to be a much better motherboard for overclocking as we were able to reach speeds of 3.46GHz.

Our 1.6125V CPU voltage may be a bit drastic. There's some speculation that Prescott could be sensitive to increased voltage and some motherboard manufacturers have gone so far as to prevent end users from adjusting the CPU voltage. Over the short term, we didn't seem to have any problems at 1.6125V and temperatures increased only 3.6 degrees (less than the total increase in our last case study), but that's not to say that problems couldn't develop over time.

by Chad Denton

3.0E GHz PENTIUM 4 & EPOX EP-4PCA3+

We managed to get our 3GHz Prescott up to 3.39GHz on a Biostar motherboard with an Intel 865G chipset. An ABIT board with an Intel 865PE chipset showed even more flexibility as we got speeds up to 3.46GHz. Now we'll test the 3GHz Prescott with Intel's high-end 875P chipset.

Motherboard

Because there appears to be little difference between the 875P and the less expensive 865PE, Canterwood chips haven't caught on with all enthusiasts. According to Intel, one of the biggest differences between its two chipsets is that the 875P supports PAT (Performance Acceleration Technology). PAT uses aggressive memory timings to reduce latency when combined with an 800MHz FSB and PC3200 DDR SDRAM. According to Intel, PAT results in a two-clock cycle reduction in latency. Apparently, however, PAT is also present in 865PE chipsets, it's just disabled. ASUS and a few other manufacturers offer 865PE boards with PAT enabled.

Running our 3GHz Prescott on an EPoX EP-4PCA3+ motherboard should give us a good indication of how Canterwood measures up to less expensive Springdale chipsets. Aside from the northbridge chipset, the EP-4PCA3+ is similar to the ABIT AI7 we used in the last case study. Both boards support up to 4GB of PC2700 or PC3200 DDR SDRAM and both boards include Intel's ICH5R on the southbridge. The ICH5R supports RAID level 0 or 1 on two SATA connectors. Both models also include five PCI slots for expansion and integrated audio chips and Ethernet controllers. The EP-4PCA3+ uses a C-Media CM9739 with a SPDIF header for digital audio output. Rather than using a standard 10/100 Ethernet controller, the EP-4PCA3+ uses on a Broadcom BCM5705 Gigabit Ethernet controller.

The EP-4PCA3+, however, does have one feature not found on the ABIT AI7. While the ICH5R limits SATA RAID to levels 0 or 1, the EP-4PCA3+ includes four IDE connectors controlled by a Highpoint HPT374 UDMA/ATA 133 RAID controller. The Highpoint controller lets you configure up to eight IDE drives in RAID 0, 1, or 5 configurations. Of course, because we're not using RAID, the Highpoint controller won't affect performance.

Overclocking

Compared to the ABIT AI7, the 875P-based EP-4PCA3+ was kind of a disappointment considering that it was more expensive. Overall, we didn't see much improvement in terms of performance. The default 6535 3Dmark03 score was virtually identical to the default score of the AI7. The overall PCMark04 score of 4765 was down 58 points. Interestingly enough, however, other PCMark04 component scores were up slightly relative to default scores from the AI7. The CPU score rose from 4587 to 4602, the Memory score rose from 4931 to 5039, the Graphics score rose from 5408 to 5431, and the HDD score rose from 4296 to 4744.

System Specs

Processor, Motherboard & Drivers	
Processor	3.0E GHz Pentium 4 (Prescott)
Motherboard	EPoX EP-4PCA3+
BIOS Manufacturer	Phoenix
BIOS Version	Award-BIOS
Chipset Driver	5.1.1.1002

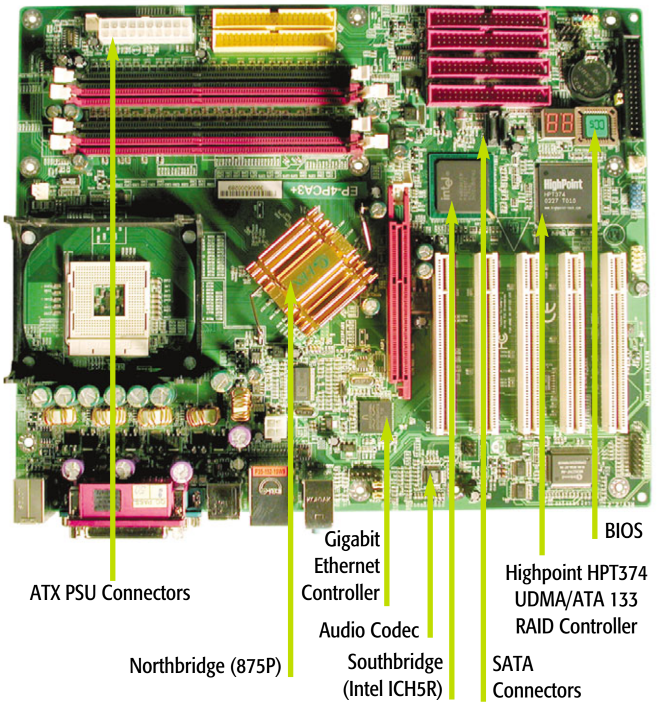
Common Components	
RAM	DDR SDRAM (2 x 512MB)
Video	Gainward PowerPack! Ultra/1800 XP Golden Sample (GeForce FX 5950 Ultra)
Hard Drive	80GB Western Digital WD800JD 7,200rpm SATA
Heatsink	Thermalright SLK-948U
CPU Fan	pcToys 92mm Tornado
CD-ROM	LiteOn Black 48X/24X/48X/16X DVD/CD-RW
Floppy	Samsung 1.44MB
Power Supply	Antec 430W TruePower
Case	Antec PLUS1080AMG
Temperature Monitor	MacPower Digital Doc 5

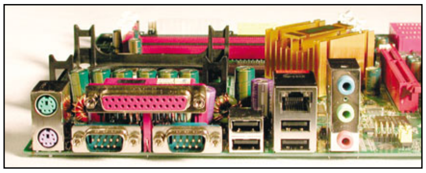
Temperature measurements were in line with our previous measurements. We measured the processor's temperature when idle at 33.7 degrees Celsius and the ambient case temperature at 28.2 C. Under load, the processor's temperature measured 40.6 C and the ambient case heat rose to 29.8 C.

After recording our default measurements, we rebooted the system and accessed the setup utility by pressing the DEL key during POST. We selected Power BIOS Features from the main menu and then selected CPU Clock/Speed. We used the PAGE UP and PAGE DOWN keys to increase the frontside bus a modest 10MHz to 210MHz. This pushed the clock speed up to 3.17GHz. Results were positive as 3Dmark03 scores shot up to 6617, just slightly more than the AI7 at the same speed. We pushed the FSB up another 10MHz to 220MHz resulting in a 3.31GHz CPU clock. Curiously, this

3.0E GHz Pentium 4 EPoX EP-4PCA3+

	Processor Speed	FSB	Multiplier	Voltage	Processor Temp	Case Temp	3Dmark03	PCMark04	PCMark04 CPU	PCMark04 Memory	PCMark04 Graphics	PCMark04 HDD
Stock Performance	3.02GHz	200MHz	15	1.375	40.6	29.8	6535	4765	4602	5039	5431	4744
Overclocked Performance	3.60GHz	239MHz	15	1.475	44.6	30.9	6721	5531	5453	5501	5573	4725


ATX PSU Connectors
Northbridge (875P)
Gigabit Ethernet Controller
Audio Codec
Southbridge (Intel ICH5R)
SATA Connectors
Highpoint HPT374 UDMA/ATA 133 RAID Controller
BIOS



increase in speed resulted in a largely unchanged 6614 3Dmark03 score.

We increased the CPU's clock speed to 3.46GHz by increasing the FSB to 230MHz. This resulted in a modest 3Dmark03 gain of 60 points to 6674. This score was slightly less than the AI7 managed at 230MHz under the processor's default voltage.

Increasing the FSB to 240MHz prevented Windows from booting. Dropping the FSB to 235MHz didn't seem to help. At 232MHz Windows booted only to freeze up, and at 231MHz, 3Dmark03 crashed. We reduced the FSB to 230MHz and increased the core voltage by selecting CPU VCore Voltage in the Power BIOS Features section of the startup utility. We increased the FSB from 1.375V to 1.425V. This resulted in a slightly better 3Dmark03 score of 6680 at 230MHz. Most importantly, however, this slight voltage increase allowed us to push up the FSB. At 232MHz, our 3GHz P4 was running at 3.49GHz. The slight increase in clock speed resulted in a small 3Dmark03 improvement to 6690. Carefully increasing the FSB to 234MHz gave us a 3.52GHz clock speed and resulted in another slight 3Dmark03 gain to 6695.

We increased the FSB again to 235MHz, which gave us a 3.54GHz P4. Again, performance rose with clock speed, as the 3Dmark03 score rose to 6708. Increasing the FSB to 237MHz caused 3Dmark03 to freeze, so we increased the CPU voltage to 1.475V. At 237MHz, the CPU clock speed was running at 3.57GHz and the 3Dmark03 score rose 5 points to 6713. In order to run the CPU at 3.6GHz, we increased the FSB to 239MHz. Once again we managed a slight improvement in 3Dmark03 as the score rose to 6721. Increasing the FSB to 241MHz caused 3Dmark03 to crash. We did manage to get the CPU running at 3.63GHz by increasing the core voltage to 1.525 and setting the FSB to 241MHz, but 3Dmark03 scores fell to 6713. Increasing the FSB further resulted in the dreaded BSOD.

We went back to our best 3Dmark03 score, which was at 3.6GHz. Even here the 6721 score was roughly equivalent to the 6726 posted by the AI7 with a 3.46GHz processor. Of course, we also had the voltage cranked up to a potentially unhealthy 1.6125V on the ABIT. Our voltage on the EP-4PCA3+ was a more reasonable 1.475V.

While 3Dmark03 scores were disappointing, PCMark04 scores looked a little more promising compared to the ABIT AI7's scores. The 5531 overall PCMark04 score was up more than 700 points from the default score. Compared to the AI7's best PCMark04 overall score, this was just over 30 points higher. The 5453 CPU score, however, is almost 200 points faster than the highest CPU score posted by the AI7 and roughly 850 points faster than our default CPU score on this board. The Memory score increased more than 450 points from 5039 to 5501. This was about 150 points slower than the best Memory score the AI7 posted. The Graphics score was up just a little more than 140 points to 5573, which was just 10 points faster than the best Graphics score posted by the AI7. The HDD score actually fell slightly to 4725.

Overclock Comparison 3Dmark03

ABIT AI7	
Stock Performance	6539
Overclocked Performance	6726
★ EPoX EP-4PCA3+	
Stock Performance	6535
Overclocked Performance	6721
Biostar P4TSV	
Stock Performance	6530
Overclocked Performance	6687

The added speed and voltage did cause temperatures to rise slightly. At 3.6GHz and 1.475V, the processor temperature measured 44.6 C under load and we measured the ambient case temperature at 30.9 C. As we mentioned, we did get the processor up to 3.63GHz, but at this speed performance suffered a bit. We had to increase the voltage to 1.525V in order to get the system stable at 3.63GHz, and this also caused a spike in temps as the CPU hit 46.1 C under load and the ambient case temp reached 31.3 C.

Final Word

We were both impressed and disappointed with the 875P-based EPoX EP-4PCA3+ board. On the plus side, we were able to reach 3.63GHz and beyond, faster than we had been able to go on any other board. At the same time, 3Dmark03 scores weren't nearly as impressive as they were on the ABIT AI7. PCMark04 scores, on the other hand, compared more favorably to the highest marks the AI7 received in PCMark04. It'll be interesting to see how future 875P-based boards compare.

by Chad Denton

3.2E GHz Pentium 4 & ECS 865G-M

System Specs

Processor, Motherboard & Drivers	
Processor	3.2E GHz Pentium 4 (Prescott)
Motherboard	ECS 865G-M
BIOS Manufacturer	Phoenix
BIOS Version	5.0f
Chipset Driver	5.0.2.103

Common Components	
RAM	DDR SDRAM (2 x 512MB)
Video	Gainward PowerPack! Ultra/1800 XP Golden Sample (GeForce FX 5950 Ultra)
Hard Drive	80GB Western Digital WD800JD 7,200rpm SATA
Heatsink	Thermalright SLK-948U
CPU Fan	pcToys 92mm Tornado
CD-ROM	LiteOn Black 48X/24X/48X/16X DVD/CD-RW
Floppy	Samsung 1.44MB
Power Supply	Antec 430W TruePower
Case	Antec PLUS1080AMG
Temperature Monitor	MacPower Digital Doc 5

In earlier case studies, the 3GHz Prescott proved more than capable of handling increased clock speeds, as we were able to get the processor above 3.6GHz on our 875P motherboard. Benchmark scores indicated performance mostly increased along with clock speed, although we did begin to see some declines at higher clock speeds.

Now we replace our 3E GHz Pentium with a faster 3.2E GHz Pentium 4. Like the 3E, the 3.2E is also based on the Prescott core. That means aside from the clock speed, both processors have a lot in common. Like the 3E, the 3.2E is based on a 90nm fabrication process that allows Intel to pack more transistors into a smaller space. Smaller transistors along with other improvements, such as a strained silicon design and a longer data pipeline, will eventually allow Intel to increase the clock speed on Prescott. For now we'll see if the faster CPU will allow higher overclocked scores.

Motherboard

In this article, we'll pair the 3.2E GHz P4 with an ECS 865G-M motherboard. The compact 865G-M can fit in smaller cases made specifically to accommodate microATX boards. Of course, the 865G-M also fit nicely in our full-sized Antec case. The smaller size, however, means fewer PCI slots for expansion. The 865G chipset does support an integrated Intel Extreme Graphics 2 video chip. Despite the integrated video, we went ahead and used our NVIDIA card to keep our test system specifications as uniform as possible.

3.2E GHz Pentium 4
ECS 865G-M

	Processor Speed	FSB	Multiplier	Voltage	Processor Temp	Case Temp	3Dmark03	PCMark04	PCMark04 CPU	PCMark04 Memory	PCMark04 Graphics	PCMark04 HDD
Stock Performance	3.20GHz	200MHz	16	1.375V	41.2	31.4	6582	5022	4819	5012	5457	4305
Overclocked Performance	3.22GHz	201MHz	16	1.375V	41.8	31.9	6607	N/A	N/A	N/A	N/A	N/A

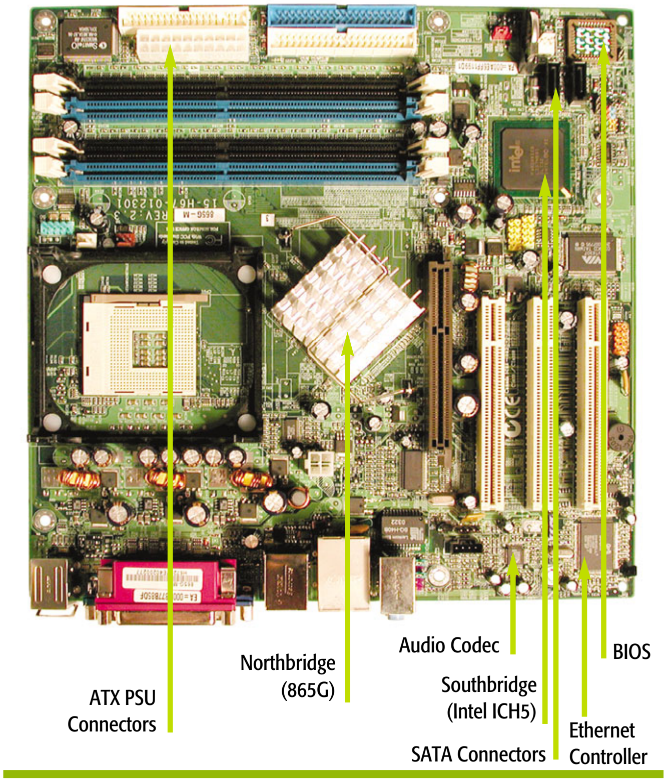
Like most other motherboards, the 865G-M also has integrated audio and Ethernet. 3Com's Marvell 940 chipset provides the Gigabit Ethernet support, while the CMI 9738A audio codec provides six-channel audio. VIA provides FireWire support while the ICH5 southbridge provides dual SATA and USB support. The 865G northbridge includes support for quad-pumped frontside bus speeds of 400MHz, 533MHz, and 800MHz. Of course, our 3.2E GHz P4 supports FSB speeds of 800MHz. Our dual 512MB memory modules let us take advantage of dual-channel memory support in the 865G.

The microATX form factor shouldn't be a limitation for overclockers. The Biostar P4TSV board we reviewed in our first Intel case study was also a microATX board and proved quite capable of providing stable overclocks at a CPU clock speed of 3.49GHz. Nonetheless, in a smaller case, heat could become more of an issue. Our Antec case provides plenty of breathing room for the processor and additional components.

Overclocking

Before attempting to overclock the system, we used the default settings to get a baseline score for our system. The 3.2E, not surprisingly, managed slightly faster benchmark scores than the 3E. The 3Dmark03 score was up 52 points over the 3E GHz P4's default score on the Biostar 865G motherboard. Some PCMark04 scores, however, increased more dramatically. The overall PCMark04 score rose nearly 200 points from 4829 to 5022. The CPU score also showed dramatic improvements, as the score increased from 4611 to 4819. The PCMark04 Memory score didn't increase as dramatically, but it was still up almost 100 points to 5012. As expected, the Graphics and HDD scores showed the least improvements. The Graphics score was up just 73 points to 5457, and the HDD score was up just 62 points to 4305.

The 865G-M used a slightly higher voltage (1.375V) than the Biostar P4TSV board (1.35V). Combined with the faster clock speed, this caused the 3.2E GHz P4 to run a little warmer than the 3E GHz. We recorded a 36.1 degree Celsius temperature for the processor when idle. By way of comparison, the 3E on the Biostar 865G-based motherboard recorded a 33.9 C temperature. This resulted in a slight increase in the ambient case temperature from 28.4 C to 29.7 C. Under load, the 3.2E GHz P4 caused the ambient case temperature to rise



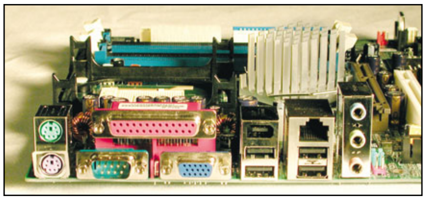
to 31.4 C and the processor temperature to climb to 41.2 C. The 3E GHz P4, on the other hand, exhibited a 38.7 C temperature under load.

Once we had our default scores recorded, we rebooted the system and pressed the DEL key during POST. This brought up the setup utility. We selected the CPU Frequency Control option and immediately noticed there was no option to increase the processor's core voltage and, thus, no way to improve stability at higher clock speeds. We've heard some motherboards have disabled CPU voltage controls when they detect a Prescott-based Pentium 4, but that didn't seem to be the case with the 865G-M motherboard, as the users manual makes no mention of a CPU voltage adjustment in the setup utility.

We were able to adjust the FSB speed by selecting CPU Clock and increasing the FSB in 1MHz increments using the PAGE UP and PAGE DOWN keys. We increased the FSB to 210MHz, saved the settings, and exited the setup utility. With our processor running at 3.36GHz, our system refused to boot properly. This marked the first time we weren't able to overclock an FSB to 210MHz. We rebooted the system and once again pressed DEL during POST to enter the setup utility. We decreased the CPU Clock option in the Frequency Control section from 210MHz to 205MHz, resulting in a 3.28GHz clock speed. Once again, the system refused to boot.

We further decreased the FSB speed to a modest 202MHz, resulting in an ever-so-slightly overclocked 3.23GHz P4. Even at this small overclock, however, the system couldn't properly boot. We decreased the FSB once again to 201MHz. At just 3.22GHz, our 3.2E GHz P4 was able to successfully boot. 3Dmark03 scores improved slightly to 6607.

We did notice an Async AGP/PCI/SATA Clk option in the Frequency Control section. It was initially set to



Sync AGP/PCI/SATA. We changed the default to 66/33/100MHz Clk hoping this might be the reason for the chronic instability. Unfortunately, increasing the FSB just 2MHz caused continued instability problems.

Obviously, the ECS 865G-M isn't made for overclockers. One reason we wanted to test the same processor on multiple boards is so that we could better tell which boards had difficulty overclocking. This is certainly the case with the ECS 865G-M. As you'll see in other studies, we were able to push speeds as high as 3.68GHz using the exact same 3.2E GHz P4 used in this article.

The ability to increase the processor's core voltage may have helped with stability. In order to reach the 3.68GHz speed, for instance, we had to pump up the core voltage to 1.625V. We can't, however, attribute all our problems with the 865G-M to the lack of a VCore option. As you'll see, our next motherboard also lacked a VCore adjustment option and, in fact, used a lower core voltage for our 3.2E GHz P4. Nonetheless, we were still able to ramp up above 3.5GHz. The truth appears to be that the ECS 865G-M just isn't a very stable motherboard for overclocking.

Overclock Comparison 3Dmark03

Chaintech 9CJS Zenith	
Stock Performance	6631
Overclocked Performance	6774
★ ECS 865G-M	
Stock Performance	6582
Overclocked Performance	6607
Shuttle AB60N	
Stock Performance	6286
Overclocked Performance	6372

Final Word

Again, one reason we tested the same processor on multiple boards is so that bad results from one board could be shown for what they are, an anomaly and not something characteristic of the processor. The ECS 865G-M is simply not a motherboard we'd recommend for overclockers. Nonetheless, we still have plenty of opportunity to see what the 3.2GHz Prescott can do when we pair it with Intel's 865PE and 875P chipsets.

An interesting note is the effect bus speed has on performance. When overclocking the 3E GHz P4 on the Biostar P4TSV, the system managed an almost identical score to the one posted by the 3.2E GHz P4 on the ECS 865G-M board. The 3E, however, managed the 6606 3Dmark03 score with a processor running at 3.15GHz and a FSB speed of 210MHz. At 201MHz, our 3.2E was running at just 3.22GHz and managed an almost identical 6607 3Dmark03 score. The faster FSB makes up for a slower processor clock in the case of these two test systems. CPU

by Chad Denton

3.2E GHz Pentium 4 & Shuttle AB60N

Thanks to the embarrassing performance turned in by the ECS 865G-M in our last case study, we still didn't have any indication how well the 3.2E GHz Prescott might overclock. We tossed the ECS board on the trash heap and bolted a Shuttle AB60N to our Antec case hoping for better results. Although not as impressive as what we saw with our 3GHz Prescott and ABIT motherboard combo, we did get much better results than we did with our ECS board.

Motherboard

The Intel 865PE on the northbridge is similar to the 865G found on our last motherboard with the major difference between the two chips being that the 865PE doesn't support Intel's integrated Extreme Graphics 2 video chip. That's not necessarily a bad thing, as it makes the 865PE more attractive to enthusiasts who aren't likely to settle for Intel's integrated graphics. The 865PE offers the same support for quad-pumped 400MHz, 533MHz, and 800MHz frontside bus speeds and support for up to 4GB of PC2100, PC2700, or PC3200 DDR SDRAM. Like all our Intel chipsets, the 865PE supports dual-channel memory. The AB60N is also larger than the ECS 865G-M board, meaning there's more room for expansion. In addition to the single 2X/4X/8X AGP slot, five additional PCI slots provide you with room to install plenty of other components such as sound cards, modems, and wireless Ethernet adapters.

The Intel ICH5 supports two independent SATA drives along with eight USB 2.0 ports. Although the ICH5 supports as many as eight USB 2.0 ports, the AB60N only has room for four USB 2.0 ports. FireWire is also noticeably absent. The AB60N also supports up to four UDMA 33/66/100 drives. The ICH5 lacks integrated RAID, and Shuttle doesn't include a separate onboard RAID controller, so if you can't live without RAID, you'll need to install a separate RAID controller. Like most other motherboards, you'll find integrated six-channel audio via the ALC650 audio codec and integrated 10/100 Ethernet via the Realtek 8100B.

In addition to having to meet certain physical specifications, most motherboards also require a BIOS update in order to support Prescott. Our motherboard arrived with the latest BIOS installed (AB60S00W released March 18, 2004). Support for Prescott was originally added in November with the AB60S00T release. That release also added support for Intel's Extreme Edition processors and removed support for older Williamette-based Pentium 4 processors. According to Shuttle's Support List (www.shuttle.com/hq/support/faq/mainboard/mb.asp), the AB60N only officially supports Prescott processors up to 2.8GHz. We had no trouble, however, with our 3.2E GHz Prescott.

System Specs

Processor, Motherboard & Drivers	
Processor	3.2E GHz Pentium 4 (Prescott)
Motherboard	Shuttle AB60N
BIOS Manufacturer	Phoenix
BIOS Version	AB60S00W
Chipset Driver	5.0.1.1015
Common Components	
RAM	DDR SDRAM (2 x 512MB)
Video	Gainward PowerPack! Ultra/1800 XP Golden Sample (GeForce FX 5950 Ultra)
Hard Drive	80GB Western Digital WD800JD 7,200rpm SATA
Heatsink	Thermalright SLK-948U
CPU Fan	pcToys 92mm Tornado
CD-ROM	LiteOn Black 48X/24X/48X/16X DVD/CD-RW
Floppy	Samsung 1.44MB
Power Supply	Antec 430W TruePower
Case	Antec PLUS1080AMG
Temperature Monitor	MacPower Digital Doc 5

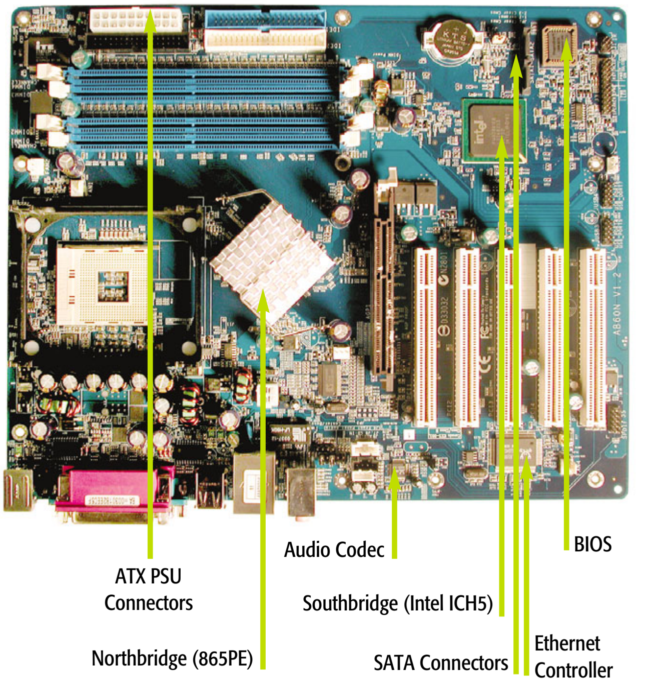
Overclocking

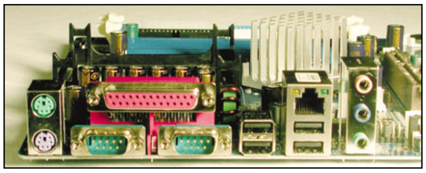
Once again, before we could reach into the system setup utility and shake things up, we had some testing to perform. Our initial 3Dmark03 score was pretty disappointing, as it was almost 300 points lower than our initial 3Dmark03 score in the last case study (6286). PCMark04 scores for the Shuttle board, however, were more encouraging. The overall PCMark04 score increased to 5040 from the last case study, and the CPU score increased from 4819 to 4889. The PCMark04 Memory score was also slightly higher, up 46 points to 5058. The Graphics score on the AB60N, however, was down 24 points relative to the ECS 865G-M to 5433. The HDD score was also down about 13 points to 4292.

Compared to the ECS board, the AB60N uses a significantly lower default

3.2E GHz Pentium 4 Shuttle AB60N

	Processor Speed	FSB	Multiplier	Voltage	Processor Temp	Case Temp	3Dmark03	PCMark04	PCMark04 CPU	PCMark04 Memory	PCMark04 Graphics	PCMark04 HDD
Stock Performance	3.21GHz	200MHz	16	1.26	43.5	30.6	6286	5040	4889	5058	5433	4292
Overclocked Performance	3.58GHz	223MHz	16	1.26	45.6	31.6	6372	5578	5438	5644	5564	4300





core voltage of 1.26V (compared to 1.375V). Despite less voltage, the 3.2E GHz was just as warm on the Shuttle board as it was on the ECS board with a 36.5-degree Celsius idle temperature. When idle, the ambient case temperature measured 29.3 C. Under load, however, the 3.2E GHz temperature increased to 43.5 C, slightly warmer than the 41.2 C load temperature measured in the previous article. The ambient default case temperature under load came in at 30.6 C.

With our default measurements carefully recorded, we rebooted the system and pressed DEL during POST to enter the system's setup utility. We selected Frequency/Voltage Control from the main menu. Like the ECS board we looked at previously, the AB60N was missing an option to increase the processor voltage. We increased the FSB to 210MHz and hoped for the best.

After rebooting the system, our 3.2E GHz processor was running at 3.37GHz. The system successfully loaded and completed 3Dmark03 with a 6328 score. This was still below the default ECS 3Dmark03 score, but at least we managed a successful overclock. We repeated the procedure and increased the FSB speed to 220MHz, yielding a 3.53GHz processor clock speed. Despite the 160MHz increase in speed, however, we only managed to gain an extra 30 points in 3Dmark03, as our score increased to 6358.

We tried increasing the FSB another 10MHz to 230MHz, but the system refused to boot with the processor running at 3.68GHz. Decreasing the FSB 5MHz to 225MHz resulted in a 3.61GHz processor, but the system proved too unstable to complete 3Dmark03. Decreasing the FSB 1MHz to 224MHz didn't help with stability. We would have tried increasing the processor's core voltage at this point if the option were available, but instead we had to settle for reducing the FSB speed yet again. We decreased the FSB to 223MHz. This time the system proved more stable with a 3.58GHz processor, and 3Dmark03 completed with a 6372 score. Once again, this score was significantly lower than the default 6582 3Dmark03 score we received in the last article.

Using the same settings, we ran PCMark04. Once again, the gains in PCMark04 benchmarks were more dramatic than they were in 3Dmark03. While 3Dmark03 scores rose just 86 points, the overall PCMark04 score rose 538 points to 5578. The PCMark04 CPU and Memory scores also rose dramatically. The CPU score increased from 4889 to 5438, and the Memory score shot up from 5058 to 5644. Our focus in these articles is on the processor, so it shouldn't be a big surprise that we don't see dramatic improvements in the Graphics and HDD scores. Nonetheless, we did note a slight improvement in the PCMark04 Graphics score, as it rose from 5433 to 5564. The HDD score remained virtually unchanged at 4300.

Overclock Comparison
3Dmark03

Chaintech 9CJS Zenith	
Stock Performance	6631
Overclocked Performance	6774
ECS 865G-M	
Stock Performance	6582
Overclocked Performance	6607
★ Shuttle AB60N	
Stock Performance	6286
Overclocked Performance	6372

Naturally, heat increased as we overclocked the FSB and processor. The processor temperature measured by our temperature probe increased from 43.5 C to 45.6 C under load at 3.58GHz. That's 2.1 C warmer than our default load temperature. The ambient case temperature increased slightly from 30.6 C to 31.6 C.

Final Word

The Shuttle AB60N is still missing one feature we like to see in a motherboard: the ability to adjust the processor's voltage. We think we probably could have managed some higher scores if we had the ability to provide a little extra voltage to the processor. As a result, we're still not really sure we can say we've seen the best the 3.2E GHz has to offer. Nonetheless, we still had much better results with the Shuttle AB60N than with the ECS 865G-M. We managed to increase the processor and FSB speeds by roughly 12%, which beats the less than 1% increase we saw in our previous article.

by Chad Denton

3.2E GHz PENTIUM 4 & CHAINTECH 9CJS ZENITH

In earlier articles we were initially disappointed with our 3.2E GHz Pentium 4, as we managed only a very slight overclock on our ECS 865G-M motherboard. Replacing the 865G-based ECS board with an 865PE Shuttle board, however, yielded more promising results, as we were able to push our processor to 3.58GHz. Now we'll move even further as we replace our 865PE motherboard with an 875P board from Chaintech.

Motherboard

If you've looked into using AOpen's AX4C motherboard with any Prescott processor, you know how frustrating Prescott compatibility issues can be. Prescott does make a few physical requirements of the motherboard. Specifically, motherboards must support FMB (Flexible Motherboard Specification) 1.5 power specifications for Prescott processors 3.2GHz and faster. FMB 1.5 motherboards are capable of supplying a higher ICC Voltage of 91A. Additionally, a BIOS upgrade is often in order to fully support Prescott. Many high-end motherboards have been supporting FMB 1.5 (or something close to it), so most motherboards are physically compatible with Prescott. As we found out, however, not all manufacturers are providing the necessary BIOS updates to support Prescott.

3.2E GHz Pentium 4
Chaintech 9CJS Zenith

	Processor Speed	FSB	Multiplier	Voltage	Processor Temp	Case Temp	3Dmark03	PCMark04	PCMark04 CPU	PCMark04 Memory	PCMark04 Graphics	PCMark04 HDD
Stock Performance	3.20GHz	200MHz	16	1.325	44.6	31.5	6631	5102	4931	5219	5455	4301
Overclocked Performance	3.65GHz	225MHz	16	1.325	45.9	31.8	6774	5759	5541	5865	5602	4296

AOpen's AX4C is one example of a motherboard in need of a BIOS update. We originally planned to use this processor with our 3.2E GHz processor, but after fixing our Prescott to the motherboard, we fired it up and found the processor running slower than it should. A little investigating showed the motherboard was using a 14X multiplier instead of a 16X multiplier. As a result, our 3.2GHz Prescott processor was running at a measly 2.8GHz.

Without a BIOS update to fix the problem, we decided we'd try to pair the AX4C with a Pentium 4 Extreme Edition processor and use Chaintech's 9CJS Zenith motherboard for the 3.2E GHz. Because the Extreme Edition processors are based on the older Northwood cores, we thought the AOpen board would provide better support for the Extreme Edition. Unfortunately, as it turned out, we weren't able to overclock the Extreme Edition on this board either. In the end, we used the Chaintech 9CJS Zenith with both the 3.2E Prescott and the 3.2GHz Extreme Edition. This should provide an interesting comparison between the older northwood-based Extreme Edition Pentium 4 processors and Intel's shiny new Prescott-based processors.

System Specs

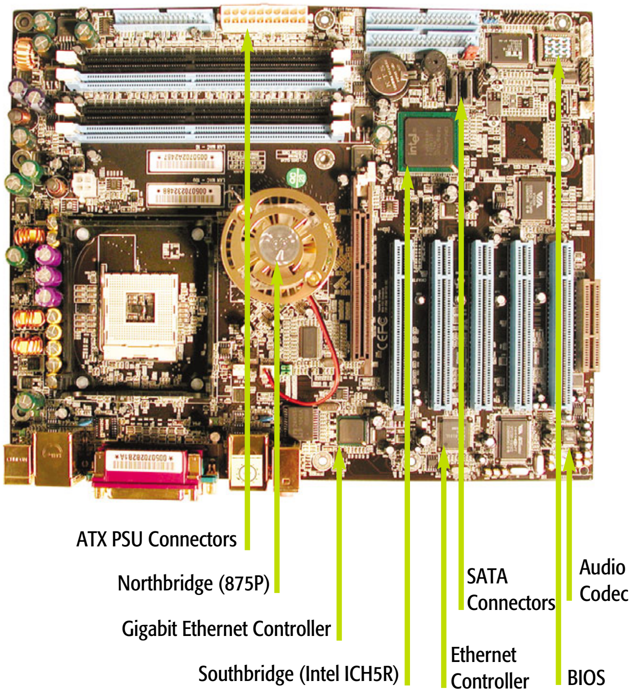
Processor, Motherboard & Drivers	
Processor	3.2E GHz Pentium 4 (Prescott)
Motherboard	Chaintech 9CJS Zenith
BIOS Manufacturer	Phoenix
BIOS Version	Ver 6
Chipset Driver	5.0.2.1002
Common Components	
RAM	DDR SDRAM (2 x 512MB)
Video	Gainward PowerPack! Ultra/1800 XP Golden Sample (GeForce FX 5950 Ultra)
Hard Drive	80GB Western Digital WD800JD 7,200rpm SATA
Heatsink	Thermalright SLK-948U
CPU Fan	pcToys 92mm Tornado
CD-ROM	LiteOn Black 48X/24X/48X/16X DVD/CD-RW
Floppy	Samsung 1.44MB
Power Supply	Antec 430W TruePower
Case	Antec PLUS1080AMG
Temperature Monitor	MacPower Digital Doc 5

The 9CJS Zenith is Chaintech's flagship Intel motherboard. The massive box immediately suggests this is a luxury board. The motherboard comes loaded with an Intel 875P northbridge chipset and an Intel ICH5R I/O controller. The system includes both an Intel PRO/1000CT Gigabit Ethernet controller and a Realtek RTL8101L 10/100 Ethernet controller. Add to that a 24-bit, 7.1-channel integrated audio codec, and the motherboard is one of the more feature-complete boards we've seen. The only thing we wish it included is a better RAID controller to go with the ICH5R.

Chaintech didn't stop with the motherboard, however. Included in the box is the CBOX3, which rests in a 5.25-inch drive bay and includes USB and FireWire connectors in addition to a 6-in-1 card reader that handles removable media such as SD, MMC, and CompactFlash cards. The Handigator is a cheesy name for a remote control, but it came included with our package, so we can't complain too much.

Overclocking

The Chaintech certainly makes a nice first impression, so we were optimistic it might deliver some top-notch performance. Sure enough, the Chaintech board provided us with some of our highest scores to date. The 6631 default 3Dmark03 score certainly helped eliminate the bad taste from the disappointing

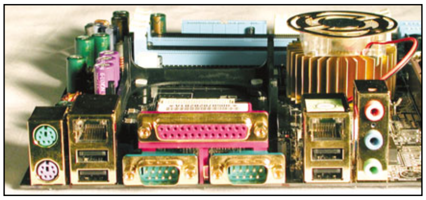


6286 default 3Dmark03 score in our last article. PCMark04 scores were also improved. The overall PCMark04 score of 5102 was one of the best scores we've received so far, and the 4931 CPU score was 42 points higher than the default score on the Shuttle board. The 9CJS Zenith's real advantage, however, appears to be in its memory subsystem, as the Zenith managed a 5219 Memory score that was 161 points higher than the Shuttle's default Memory score. Finally, we saw slight improvements in both the Graphics score (5455) and HDD score (4301).

Our temperature probes reported an idle processor temperature of 36.2 degrees Celsius and 29 C for the ambient case temperature, which is in line with other temperature readings from the 3.2E GHz processor. Under load, however, the processor's temperature was 1.1 C warmer than the default temperature in our last article and 3.4 C warmer than it was with the ECS board. With the processor working hard, the ambient case temperature reached 31.5 C, which was similar to default load temperatures we observed previously.

We pressed DEL during POST to enter the system setup utility. We then selected Frequency/Voltage Control from the main menu. Considering the 9CJS is meant to be an enthusiast's board, we weren't surprised to see a reasonable number of overclocking options. Aside from the Default setting, 44 voltage settings were available with a range from 1.1V to 1.675V. Such fine-grain voltage control can certainly be helpful when it comes to stabilizing your processor at higher clock speeds, and it stands in stark contrast to the two other motherboards we paired with the 3.2E GHz (neither of which allowed you to adjust the CPU voltage).

We selected CPU Clock and used PAGE UP to adjust the setting to 210MHz, which increased our processor's clock speed from 3.2GHz to 3.41GHz. The increased speeds resulted in a modest 65-point gain in 3DMark04. We returned to the system setup utility and increased the FSB to 220MHz. After rebooting, our 3.57GHz Prescott managed a 54-point increase to 6740.



Unfortunately, the system failed to boot when we increased the FSB to 230MHz. Reducing the FSB to 225MHz (3.65GHz), however, resulted in a solid 6774 3Dmark03 score. We were able to get a 3Dmark03 score of 6682 at 226MHz, but that score was slightly lower than the 3Dmark03 score we received at 225MHz. The system rebooted constantly at both 226MHz and 227MHz.

Increasing the CPU voltage from 1.325V to 1.425V improved our 3Dmark03 score at 226MHz, but even then the 6762 score was slightly lower than the 6774 score we received at 225MHz with our default voltage. The higher voltage allowed us to boot the system successfully, but 3Dmark03 crashed before rendering a score. Increasing the voltage to 1.525V didn't help matters, but at 1.625V, we were able to get a 3Dmark03 score with a 227MHz FSB speed and 3.68GHz processor speed. Unfortunately, the score continued the downward trend we had observed since the 225MHz mark. At 6377, 3Dmark03 was dramatically lower than it was at 225MHz.

We returned the voltage to 1.325V and lowered the FSB to 225MHz before running PCMark04. While 3Dmark03 scores only improved a modest 143 points, PCMark04 scores increased dramatically, with the Overall score, CPU score, and Memory scores all showing increases in excess of 600 points. The Overall PCMark04 score shot up to 5759, while the CPU score and Memory score improved to 5541 and 5865 respectively. As always, we saw less change in the Graphics and HDD scores. The Graphics score still showed slight improvement from 5455 to 5602, while the HDD score was down slightly from 4301 to 4296.

Overclock Comparison 3Dmark03

★ Chaintech 9CJS Zenith	
Stock Performance	6631
Overclocked Performance	6774
ECS 865G-M	
Stock Performance	6582
Overclocked Performance	6607
Shuttle AB60N	
Stock Performance	6286
Overclocked Performance	6372

Final Word

Not only does the Chaintech board come with plenty of features, but it also delivers impressive performance and overclocks well. We were a little disappointed to see scores go down as we moved past 3.65GHz, but the dramatic PCMark04 results were certainly impressive. CPU

by Chad Denton

3.2GHz PENTIUM 4 EXTREME EDITION & ASUS P4G800-V

We started off looking at Intel's new Prescott-based Pentium 4 processors which include several changes designed to help Intel push clock speeds even higher. As speeds increase, Prescott is likely to become more impressive. Currently, however, Prescott doesn't seem to compete very well with older processors based on the Northwood core. One reason is that Intel actually extended Prescott's instruction pipeline. Because the processor is constantly flooding the pipeline with data it expects the processor will need, the longer pipeline isn't bad until the processor mispredicts what data the processor will need. A misprediction is costly because the processor has to empty the pipeline and resend the correct data.

At current speeds, Northwood is still competitive with Prescott, and if you're a gamer, there may be no better Intel processor for you than a Pentium 4 Extreme Edition. The Extreme Edition is based on the Northwood core, which means it uses the 13-micron (1.3 nanometer) fabrication process. Northwood has just half the L2 cache of Prescott, but it includes a special 2MB of L3 cache. The added cache makes a big difference when it comes to gaming and an even bigger difference when it comes to cost. Extreme Edition processors are the most expensive processors Intel has on the market.

When we overclocked high-end Northwood processors several months ago, we noticed less overhead as clock speeds increased. We simply couldn't push faster processors as far as we could slower ones. Furthermore, we often saw performance scores decrease as clock speeds increased. We've had an easy time pushing Prescott speeds, but now it's time to turn our attention back to Northwood-based processors. We paired our 3.2GHz Pentium 4 Extreme Edition (not to be confused with the 3.2E GHz, which is a Prescott chip) with an 865G motherboard from ASUS.

Motherboard

ASUS is one of the big names in overclocking and the company has a reputation for stable, reliable boards that overclock well. As we've said in the past, however, most companies don't target the enthusiast with their 865G motherboards. The main reason is that an enthusiast simply isn't going to be happy with a low-end integrated Intel video chip. As a result, it seems 865G motherboards are harder to overclock and, in some instances, don't even allow users to increase the FSB.

Unlike our last two 865G motherboards, the P4G800-V is a full-sized ATX board instead of a microATX board like the Biostar P4TSV and the ECS 865G-M. While the latter boards are compatible with smaller cases, the P4G800-V provides more expansion options, including six PCI slots and one 4X/8X AGP slot. An alternate version, the P4G800-VM, is a microATX boards with three PCI slots.

The 865G supports 400MHz, 533MHz, and 800MHz quad-pumped FSB speeds along with up to 4GB of dual-channel PC3200 DDR SDRAM. Hyper-Threading support and support for processors up to 3.4GHz is also provided by this motherboard. Like the 3.2E GHz Prescott chip we looked at earlier, the 3.4GHz Extreme Edition also requires the motherboard to conform to FMB 1.5 specifications. The FMB 1.5 specification provides more amperes to the processor (91A compared to 78A). Luckily, the P4G800-V meets FMB 1.5 requirements. The motherboard contained the latest BIOS update (1008) with support for our 3.2GHz Pentium 4 Extreme Edition first appearing in revision 1005.

On the southbridge, the P4G800-V features an Intel ICH5, which supports up to

System Specs

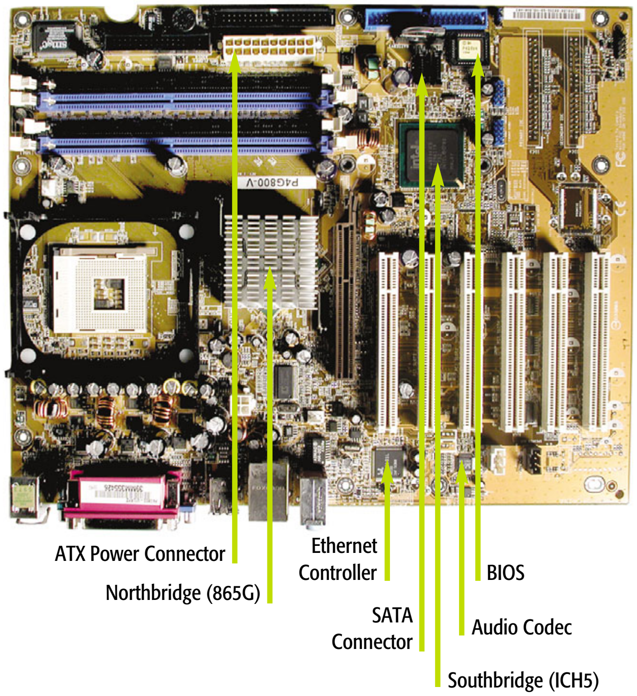
Processor, Motherboard & Drivers	
Processor	3.2GHz Pentium 4 Extreme Edition
Motherboard	ASUS P4G800-V
BIOS Manufacturer	AMI
BIOS Version	1008
Chipset Driver	5.0.2.1003
Common Components	
RAM	DDR SDRAM (2 x 512MB)
Video	Gainward PowerPack! Ultra/ 1800 XP Golden Sample (GeForce FX 5950 Ultra)
Hard Drive	80GB Western Digital WD800JD 7,200rpm SATA
Heatsink	Thermalright SLK-948U
CPU Fan	pcToys 92mm Tornado
CD-ROM	LiteOn Black 48X/24X/48X/16X DVD/CD-RW
Floppy	Samsung 1.44MB
Power Supply	Antec 430W TruePower
Case	Antec PLUS1080AMG
Temperature Monitor	MacPower Digital Doc 5

3.2GHz Pentium 4 Extreme Edition
Asus P4G800-V

	Processor Speed	FSB	Multiplier	Voltage	Processor Temp	Case Temp	3Dmark03	PCMark04	PCMark04 CPU	PCMark04 Memory	PCMark04 Graphics	PCMark04 HDD
Stock Performance	3.2GHz	200MHz	16	1.475	38.5	28	6311	5239	4933	5090	5647	4267
Overclocked Performance	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

eight USB 2.0 ports and two independent SATA 150 drives. The motherboard also supports two UDMA 100 IDE connectors (for a total of four devices).

With chips being so inexpensive, it's hard to find a motherboard that doesn't include integrated audio and Ethernet. The Realtek ALC650 provides six channels of audio and the integrated Realtek 8101L Ethernet controller provides 10/100 Ethernet connectivity.

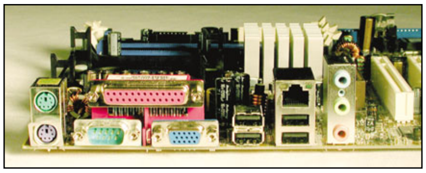


Overclock

Although the P4G800-V supports our 3.2GHz Pentium 4 Extreme Edition, the AMI BIOS lacked an option to adjust the motherboard's FSB. This was extremely disappointing for an ASUS-branded motherboard as it prevented us from overclocking the board.

The AMI BIOS is a little different from the Phoenix BIOS we've seen in motherboards to this point. To access the setup utility, we still pressed the DEL key during POST. The layout of the BIOS, however, was very different. We navigated tabs across the top of the screen using the Left and Right arrow keys and selected options on the screen using the Up and Down arrow keys. Under the Main tab, there is a submenu for system information. This screen provides the processor type and clock speed, but there are no options to adjust or change the CPU or FSB speeds. Under the Advanced tab, there is a CPU Configuration option, but again this provides mostly information. The processor manufacturer, brand, frequency, multiplier status, and multiplier value are listed here.

There are some useful settings in the Chipset section under the Advanced tab, but again no option to modify the FSB. You can Disable Configure DRAM Timing By SPD to manually adjust your memory timings. Once disabled, you can adjust DRAM CAS# Latency, DRAM RAS# Precharge, DRAM RAS# To CAS# Delay, DRAM Precharge Delay, and DRAM Burst Length. You can also adjust the amount of system memory used for video memory in the Chipset section.



Despite the lack of a FSB adjustment, we went ahead and ran our benchmarks to get an idea how the 3.2GHz Extreme Edition stacks up to its Prescott cousins in terms of performance. The P4G800-V ran our Extreme Edition with a default voltage of 1.475V. 3Dmark03 returned a somewhat disappointing 6311 score for our 3.2GHz processor. This was 271 points less than the 6582 score posted by the 3.2GHz Prescott on the ECS 865G-M motherboard.

Typically, the extra cache seems to have more of an impact on application benches such as 3Dmark03. In this case, however, PCMark04 scores seemed to be higher relative to the 3.2GHz Prescott on the 865G-M board. The Overall PCMark04 score of 5239 was more than 200 points better than the 5022 score posted by the 3.2GHz Prescott and the 4933 CPU score was more than 100 points higher than the 4819 CPU score posted by the Prescott. We did see a higher than expected increase in the Graphics score as we managed a 5647 with our 3.2GHz EE that was 190 points higher than our 3.2GHz Prescott. The Memory score showed only a slight improvement to 5090 from 5012 and the HDD score was down slightly from 4305 to 4267.

We've heard a lot about just how hot Prescott runs. Our heat probes, of course, aren't in contact with the processor's core, so our measurements are only an indirect indicator of the chip's heat. Comparing our default readings for Prescott processors with our readings for Northwood-based Extreme Edition processors, however, demonstrate just how much hotter Prescott runs. Our 3.2GHz Prescott's temperature ranged from 41.2 degrees Celsius under load to 44.6 C. Under load, our 3.2GHz EE ran at 38.5 C. The Prescott system had an ambient case temperature of around 30 C, while ambient case temperatures rested at around 28 C when running our 3.2GHz Extreme Edition.

Overclock Comparison
3Dmark03

Chaintech 9CJS Zenith	
Stock Performance	6671
Overclocked Performance	6809
Soyo SY-P4I865PE Plus Dragon 2	
Stock Performance	6292
Overclocked Performance	6379
★ ASUS P4G800-V	
Stock Performance	6311
Overclocked Performance	N/A

Final Word

The lack of overclocking options is a real disappointment, especially for an ASUS board. Nonetheless, our default scores provide an interesting glimpse as to how our Northwood-based Extreme Edition fares compared to a newer processor running Intel's Prescott core. CPU

by Chad Denton

3.2GHz Pentium 4 Extreme Edition & Soyo SY-P4I865PE Plus Dragon 2

After a disappointing run with a 3.2GHz Pentium 4 Extreme Edition and an ASUS 865G motherboard, we were anxious to move on and see just how far we could push this already speedy processor. This time we paired our 3.2GHz Extreme Edition with an 865PE chipset. The 865PE is more popular with enthusiasts because it offers excellent performance for the price.

Motherboard

For this case study, we used the Soyo P4I865PE Plus Dragon 2. This board isn't to be confused with the Soyo P4I865PE Dragon 2 Plus. Both boards include an Intel 865PE chipset on the northbridge and an Intel ICH5 on the southbridge. Our motherboard, however, has just three memory slots. That means that although the motherboard supports dual-channel DDR SDRAM up to PC3200 speeds, you won't be able to take full advantage of dual-channel memory if you fill all slots. Both boards also include five PCI slots and one 4X/8X AGP slot. The alternate board, however, includes a CNR slot that our board lacks.

The 865PE supports 400MHz, 533MHz, and 800MHz quad-pumped FSB speeds, and the motherboard itself is capable of supporting Prescott and Extreme Edition processors. The ICH5 on the southbridge supports two independent SATA RAID devices and as many as eight USB 2.0 devices. A CMI 9739A integrated audio codec provides six-channel audio and a Davicom DM9102 provides 10/100 Ethernet connectivity.

Overclocking

We eventually got some first-rate results from the P4I865PE, but we had to play with some of the system settings in order to stabilize the system at higher FSB speeds. We started off, as always, by benchmarking the system with its default settings.

At 3.2GHz, our Extreme Edition processor managed a 6292 3Dmark03 score. This score was essentially the same as the 6286 3Dmark03 score we received with our 3.2GHz Prescott on a Shuttle AB60N 865PE motherboard and was slightly lower than the 6311 score we got in the last case study. The 5171 Overall PCMark04 score was about 131 points faster than the Overall PCMark04 score posted by the 3.2GHz Prescott on an 865PE motherboard, but it was down 128 points from our last article. Compared to the CPU score posted by our 3.2GHz Prescott chip, the Extreme Edition's CPU score was down 45 points to 4844. Once again, this score was significantly lower than in our last article as was the 4947 Memory score. The Memory score for our Extreme Edition processor was lower than the 3.2GHz Prescott's. The 5638 Graphics score, however, was on a par with the score from our last case study and was 205 points better than the 3.2GHz Prescott managed. The 4291 HDD score was up slightly from our last article.

Under load, we recorded a temperature of 38.8 degrees Celsius for our 3.2GHz Extreme Edition. This was similar to the 38.5 C temperature we recorded in our last case study and it was significantly lower than the 43.5 C temperature we recorded with our 3.2GHz Prescott processor under load. The ambient case temperature for our system was also consistent with our last article at 29 C.

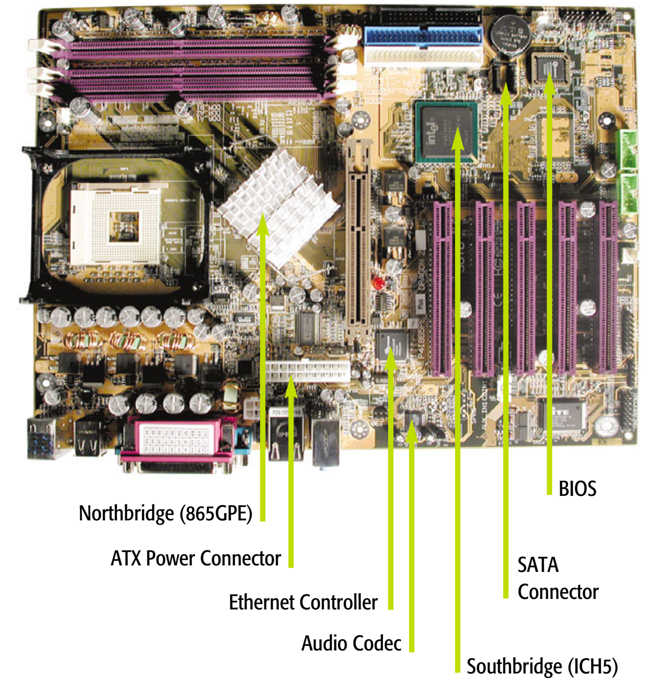
After recording the default scores, we rebooted the system and accessed the system setup utility by pressing DEL during POST. We selected the first entry in the main menu, Soyo COMBO Feature. We then selected CPU Frequency Select and changed the value from Auto to Manual. We were than able to adjust the Select

System Specs

Processor, Motherboard & Drivers	
Processor	3.2GHz Pentium 4 Extreme Edition
Motherboard	Soyo P4I865PE Plus Dragon 2
BIOS Manufacturer	Phoenix Award BIOS
BIOS Version	P4IP2_2BA1
Chipset Driver	5.0.1.1015
Common Components	
RAM	DDR SDRAM (2 x 512MB)
Video	Gainward PowerPack! Ultra/1800 XP Golden Sample (GeForce FX 5950 Ultra)
Hard Drive	80GB Western Digital WD800JD 7,200rpm SATA
Heatsink	Thermalright SLK-948U
CPU Fan	pcToys 92mm Tornado
CD-ROM	LiteOn Black 48X/24X/48X/16X DVD/CD-RW
Floppy	Samsung 1.44MB
Power Supply	Antec 430W TruePower
Case	Antec PLUS1080AMG
Temperature Monitor	MacPower Digital Doc 5

3.2GHz Pentium 4 Extreme Edition Soyo SY-P4I865PE Plus Dragon 2

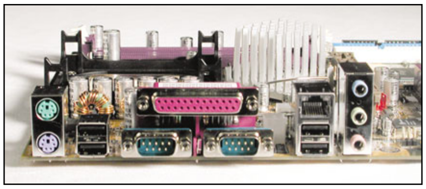
	Processor Speed	FSB	Multiplier	Voltage	Processor Temp	Case Temp	3Dmark03	PCMark04	PCMark04 CPU	PCMark04 Memory	PCMark04 Graphics	PCMark04 HDD
Stock Performance	3.2GHz	200MHz	16	1.47	38.8	29	6292	5171	4844	4947	5638	4291
Overclocked Performance	3.6GHz	225MHz	16	1.47	40.3	28.2	6379	5812	5065	5577	5658	4282



Frequency 1MHz Stepping entry from 200MHz to 210MHz. Unfortunately, the system refused to boot, so we returned to the system setup utility and decreased the FSB to 205MHz. Again the system refused to boot. Scaling back the FSB to 201MHz resulted in a 3.21GHz overclock and a 3Dmark03 score that was virtually unchanged at 6295, but at least we had a successful overclock. We moved the FSB up to 202MHz and managed to improve our 3Dmark03 score to 6300 with a 3.23GHz processor, but the results were pretty disappointing.

We turned to our old stability standby fix, the CPU Voltage. We increased the voltage from 1.47V to 1.5V and 1.6V, but the system refused to boot. That's when we returned to the setup utility and noticed the Async AGP/PCI Clk was set to Disabled. This means the AGP and PCI clocks are trying to keep pace with the FSB, which can cause instability. Locking the AGP and PCI bus at an appropriate speed will cost you a little in terms of performance, but it will go a long way toward increasing the systems stability and allow you to overclock the processor further. We set this option to 33/66MHz, returned our CPU Voltage to 1.47V, and increased our FSB speed to 205MHz. The system not only booted successfully, but it even completed 3Dmark03. Unfortunately, the score showed only a modest improvement to 6302, but at least we knew we were on the right track.

We increased the frontside bus to 210MHz resulting in a 3.36GHz processor. This time we started seeing some significant improvements as the 3Dmark03 score increased to 6337. We pushed the frontside bus on the Extreme Edition further to 220MHz and the system remained stable with the processor running at 3.52GHz. At this speed, the 3Dmark03 score increased to 6374, and actually topped the 3Dmark03 score for our 3.2GHz Prescott chip running at the same speed.



Increasing the frontside bus to 230MHz prevented the system from booting, so we dropped the FSB down to 225MHz. Our 3.6GHz processor managed a 6379 3Dmark03 score. We were actually able to get the 3.2GHz Extreme Edition running slightly faster than our 3.2GHz Prescott processor on an 865PE motherboard.

Overclock Comparison 3Dmark03

Chaintech 9CJS Zenith	
Stock Performance	6671
Overclocked Performance	6809
★ Soyo SY-P4I865PE Plus Dragon 2	
Stock Performance	6292
Overclocked Performance	6379
ASUS P4G800-V	
Stock Performance	6311
Overclocked Performance	N/A

Attempts to push the FSB speeds higher kept the system from booting and increasing the CPU voltage was little help, so we returned to 225MHz and ran PCMark04. Scores showed dramatic improvement over the processor's original scores. The Overall PCMark04 score increased 641 points to 5812 and the CPU score increased 221 points to 5065. The Memory score showed a dramatic improvement up 630 points to 5577 while the Graphics score showed a more modest 20-point increase to 5658. The HDD score decreased very slightly this time around to 4282.

The PCMark04 scores compared favorably to the PCMark04 scores we received from the 3.2GHz Prescott running at 3.58GHz. The Prescott's Overall PCMark04 score was dramatically lower at 5578, but the Prescott enjoyed a higher 5438 CPU score. The Prescott lagged behind in the Memory score with a 5644 and the Graphics score was slightly lower at 5564. The 4300 HDD score enjoyed a slight advantage over our more recent benchmark score.

Final Word

The Soyo P4I865PE Plus Dragon 2 provides the first glimpse into what kind of overclocking performance we can expect from the 3.2GHz Extreme Edition with its Northwood core. We were surprised that the Extreme Edition, at least when paired with the Soyo board, offered a little more overclocking headroom than our 3.2GHz Prescott. Next, we'll slap our Intel 3.2GHz Extreme Edition into Chaintech's 875P motherboard and see just how well the Extreme Edition processor compares directly with our 3.2GHz Prescott.

by Chad Denton

3.2GHz Pentium 4 Extreme Edition & Chaintech 9CJS Zenith

System Specs

Processor, Motherboard & Drivers	
Processor	3.2GHz Pentium 4 Extreme Edition
Motherboard	Chaintech 9CJS Zenith
BIOS Manufacturer	Phoenix
BIOS Version	Ver. 6
Chipset Driver	5.0.2.1002

Common Components	
RAM	DDR SDRAM (2 x 512MB)
Video	Gainward PowerPack! Ultra/1800 XP Golden Sample (GeForce FX 5950 Ultra)
Hard Drive	80GB Western Digital WD800JD 7,200rpm SATA
Heatsink	Thermalright SLK-948U
CPU Fan	pcToys 92mm Tornado
CD-ROM	LiteOn Black 48X/24X/48X/16X DVD/CD-RW
Floppy	Samsung 1.44MB
Power Supply	Antec 430W TruePower
Case	Antec PLUS1080AMG
Temperature Monitor	MacPower Digital Doc 5

With our 865PE-based Soyo P4I865PE Plus Dragon 2 motherboard, we were finally able to overclock our 3.2GHz Pentium 4 Extreme Edition. For our efforts we got some fairly impressive results. We added 400MHz to the processor's default speed and managed to get it running well at 3.6GHz, which was just slightly faster than the 3.58GHz speed we achieved with our 3.2GHz Prescott. Now we'll combine the Extreme Edition with a motherboard we've seen before, Chaintech's 9CJS Zenith.

Motherboard

We first saw the Chaintech 9CJS Zenith when we looked at the 3.2E GHz Prescott. We used the Chaintech board to replace the AOpen AX4C motherboard, which lacked Prescott support. We had hoped that the AOpen would run our Extreme Edition with its older Northwood core. Unfortunately, the Extreme Edition has some of the same power requirements as Prescott. The motherboard's deficiencies were apparent every time we tried to run 3Dmark03—the board simply crashed. We ended up scraping the AX4C completely. For this case study we opted to use the Chaintech 9CJS once again. This will give us an opportunity to directly compare the 3.2GHz Prescott to our 3.2GHz Extreme Edition.

This particular board is Chaintech's flagship product and it includes Intel's flagship chipset, the 875P. Like the 865PE, the 875P includes support for up to 4GB of dual-channel memory (up to PC3200), 8X AGP, and FSB speeds as high as 800MHz (quad-pumped, of course). The 875P, however, supports Intel's PAT technology which provides more aggressive memory timings when using dual-channel PC3200 memory. The ICH5R supports RAID 0 or 1 on the two independent SATA connectors.

Like most motherboards, the Chaintech includes integrated audio, but unlike most boards, the audio codec supports 7.1 surround sound. Integrated Ethernet is also included, but rather than one Ethernet controller, Chaintech provides dual controllers. A Realtek RTL8101L provides standard 10/100 Ethernet connectivity, while an Intel PRO/100CT provides Gigabit Ethernet connectivity.

But Chaintech doesn't stop with those impressive motherboard features. The 9CJS Zenith also includes the CBOX3, which fits into an external 5.25-inch drive bay and includes USB and FireWire ports in addition to a 6-in-1 card reader that handles a wide range of removable media from SD to Memory Stick. Chaintech includes assorted faceplates to make the CBOX3 match your case color.

Overclock

We were looking forward to seeing how far we could push the 3.2GHz Extreme Edition compared to the 3.2GHz Prescott we looked at earlier. At default speeds, the 3.2GHz Extreme Edition seemed to have a slight advantage over the Prescott. The 6671 3Dmark03 score was 40 points faster than the 6631 score posted by our Prescott processor on the same motherboard.

PCMark04 scores also seemed to favor our 3.2GHz Extreme Edition. The 5384 Overall PCMark04 score was significantly faster than the 5102 score posted by Prescott. The 5043 CPU score also favored our Extreme Edition by 112 points. We were initially impressed by the Chaintech board's Memory scores when we tested it with our Prescott, but we were even more impressed with the 5364 Memory score we got with our Extreme Edition processor. That's 145 points higher than with the Prescott running at the same speed. We usually don't see much of a difference in the Graphics scores either, but the Extreme

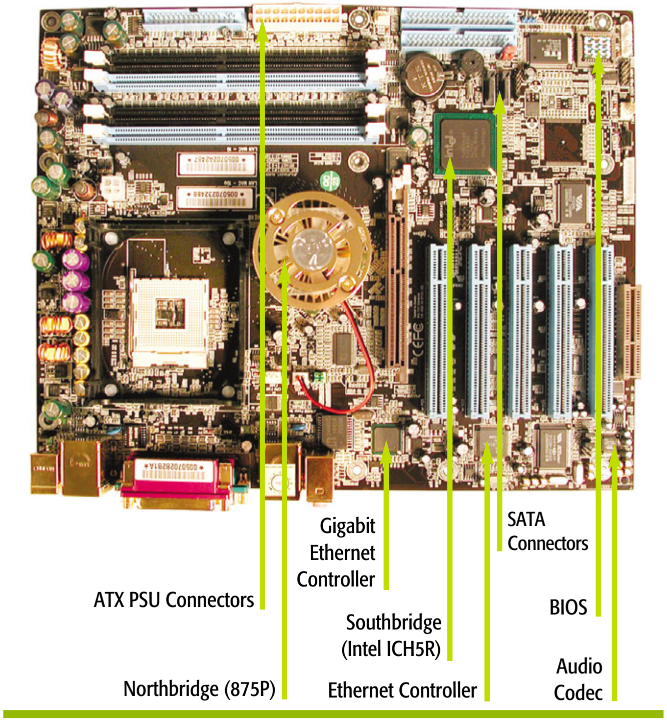
3.2GHz Pentium 4 Extreme Edition
Chaintech 9CJS Zenith

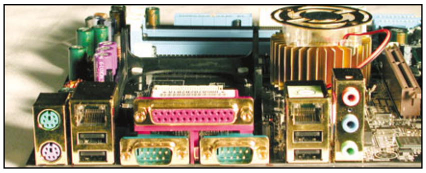
	Processor Speed	FSB	Multiplier	Voltage	Processor Temp	Case Temp	3Dmark03	PCMark04	PCMark04 CPU	PCMark04 Memory	PCMark04 Graphics	PCMark04 HDD
Stock Performance	3.20GHz	200MHz	16	1.5	38.4	30.4	6671	5384	5043	5364	5630	4300
Overclocked Performance	3.65GHz	225MHz	16	1.6	41.2	31.6	6814	5920	5477	6034	5648	4293

Edition managed to outscore our Prescott by 175 points with its 5630. The HDD scores were virtually identical with the Prescott posting 4301 and the Extreme Edition posting 4300.

Compared to the previous article, 3Dmark03 scores were up 379 points, which is a huge amount for this benchmark. PCMark04's Overall, CPU, and Memory scores were also all up significantly. The Graphics and HDD scores, on the other hand, differed very slightly.

Again, CPU and case temperatures were similar to what we've seen in the last two articles. The processor temperature under load reached 38.4 degrees Celsius and the ambient case temperature reached 30.4 C. Previous 3.2GHz Extreme Edition temperatures were all around 38 C and ambient case temperatures were around 29 C.





After recording the default information, we started overclocking the Extreme Edition. During POST, we pressed the DELETE key to enter the system setup utility. From here, we selected Frequency/Voltage Control and then Select CPU Clock. We used PAGE UP and PAGE DOWN to change the value from the default 200MHz to 210MHz. This increased our processor speed from the default 3.2GHz to 3.41GHz and resulted in a significant 3Dmark03 improvement to 6729. We were easily able to increase the processor's clock speed to 3.57GHz by increasing the FSB to 220MHz. This yielded a 6768 3Dmark03 score.

Earlier we were able to reach 3.65GHz with our Prescott processor without increasing the processor's core voltage. At 3.65GHz, however, our system was unable to boot. We decreased the FSB from 225MHz to 223MHz and managed a 6793 3Dmark03 score. Increasing the FSB to 224MHz increased our processor's clock speed from 3.62GHz to 3.63GHz and increased 3Dmark03 scores to 6810. We increased our CPU Voltage from the default 1.5V to 1.6V and then increased the FSB back to 225MHz. This time, the system proved stable at 3.65GHz and we managed a 6814 3Dmark03 score.

Increasing the FSB to 226MHz caused Windows to reboot. We were able to get the system stable at 3.68GHz by increasing the CPU Voltage to 1.675V, but our 3Dmark03 score began to fall with the FSB at 227MHz. We had seen this earlier with our Prescott processor. Subsequent attempts to overclock the motherboard proved unsuccessful.

Overclock Comparison 3Dmark03

★ Chaintech 9CJS Zenith	
Stock Performance	6671
Overclocked Performance	6809
Soyo SY-P4I865PE Plus Dragon 2	
Stock Performance	6292
Overclocked Performance	6379
ASUS P4G800-V	
Stock Performance	6311
Overclocked Performance	N/A

We returned to the 225MHz FSB speed that had provided us with our best 3D-mark03 score. Interestingly enough, this is the same speed at which our Prescott provided its best performance. PCMark-04 scores showed significant improvements as the Overall PCMark03 score rose 536 points to 5920. The CPU score saw a similar improvement of 434 points to 5477. Most dramatic, however, was the 670 point increase in our Memory score as it topped the 6000 mark to 6034. The Graphics and HDD scores, on the other hand, were largely unchanged. The Graphics score increased 18 points to 5648 and the HDD score fell 7 to 4293.

Once again, most scores were up dramatically compared to the 3.2GHz Prescott on the same motherboard and running at the same 3.65GHz speed. The Extreme Edition's 6814 3Dmark03 score was 40 points higher than the Prescott's. The Extreme Edition's PCMark04 Overall and Memory scores were all significantly higher than the Prescott's. The Overall PCMark04 score was 161 points higher, while the Memory score was up 169 points. Interestingly enough, however, the Prescott managed a slight advantage in the CPU score as Prescott proved almost 65 points faster. The Extreme Edition did manage a 46 point higher Graphics score, while the HDD scores were virtually identical.

Final Word

Comparing the Chaintech 9CJS Zenith to the Soyo and ASUS boards we examined earlier makes it clear that Chaintech's 875P board not only provides a number of high-end features, but also delivers on performance and stability. Being able to compare the 3.2GHz versions of Prescott and Extreme Edition also proved interesting. We were able to get our best scores from both CPUs at 3.65GHz, but the Extreme Edition won most of the benchmarks. CPU

by Chad Denton

3.4GHz Pentium 4 Extreme Edition & Gigabyte GA-8IG1000 Pro-G

About the time Intel officially released its new Prescott core, it announced a newer, faster Pentium 4 Extreme Edition. Like the earlier Extreme Edition, the new processor was based on a Northwood core with a 13-micron fabrication process and 512KB L2 cache. Like its predecessor, the new chip also featured a massive 2MB L3 cache. The new chip, however, ran at a slightly higher clock speed of 3.4GHz. Since that time, Intel has announced an updated LGA-based 3.4GHz Extreme Edition. Unfortunately, that announcement came much too close to press time for us to procure the latest Extreme Edition. Regardless, we were able to take a look at the original 3.4GHz Pentium 4 Extreme Edition, which is still one of the fastest processors on the market.

Motherboard

We've been pretty down on 802.11G motherboards with good reason. Overclocking results on 865G motherboards have been lackluster at best and, on at least one occasion, we were completely unable to overclock the motherboard at all. Again, we think you have to go back to the inclusion of an integrated graphics chip with the 865G board. Enthusiasts and overclockers simply aren't going to be happy with an integrated video chip, so why drive up motherboard costs by using high-end components?

Gigabyte has elected to follow a different path. Its GA-8IG1000 Pro-G motherboard includes components and features commonly found on higher-end models. The integrated Realtek ALC850 audio codec, for instance, provides 7.1 surround sound and the Marvell Gigabit Ethernet controller goes far beyond the 10/100 Ethernet controllers found on most other 865G boards. Another interesting feature is Gigabyte's MIB (Memory Intelligent Booster). According to Gigabyte, MIB reduces memory latency and increases memory bandwidth by as much as 10%. Is it just us or does that sound strangely similar to Intel's PAT (Performance Acceleration Technology)? PAT, of course, is only officially supported on 875P chipsets, but we've seen some motherboard manufacturers enabling PAT on 865PE chipsets.

The 865G, of course, includes support for Intel's Extreme Graphics Engine 2 video chip. If you prefer to use something more powerful, the GA-8IG1000 Pro-G motherboard also includes a 4X/8X AGP slot. Like the 865PE and 875P, the 865G supports FSB speeds as high as 800MHz and up to 4GB of dual channel PC3200 DDR SDRAM.

Gigabyte paired the 865G with an Intel ICH5 on the southbridge. The ICH5, of course, doesn't support SATA RAID 0 or 1 the way the ICH5R does. We missed the RAID options all the more considering all the other high-end features on this board.

System Specs

Processor, Motherboard & Drivers	
Processor	3.4GHz Pentium 4 Extreme Edition
Motherboard	Gigabyte GA-8IG1000 Pro-G
BIOS Manufacturer	Award BIOS
BIOS Version	F3
Chipset Driver	5.1.1.1002
Common Components	
RAM	DDR SDRAM (2 x 512MB)
Video	Gainward PowerPack! Ultra/1800 XP Golden Sample (GeForce FX 5950 Ultra)
Hard Drive	80GB Western Digital WD800JD 7,200rpm SATA
Heatsink	Thermalright SLK-948U
CPU Fan	pcToys 92mm Tornado
CD-ROM	LiteOn Black 48X/24X/48X/16X DVD/CD-RW
Floppy	Samsung 1.44MB
Power Supply	Antec 430W TruePower
Case	Antec PLUS1080AMG
Temperature Monitor	MacPower Digital Doc 5

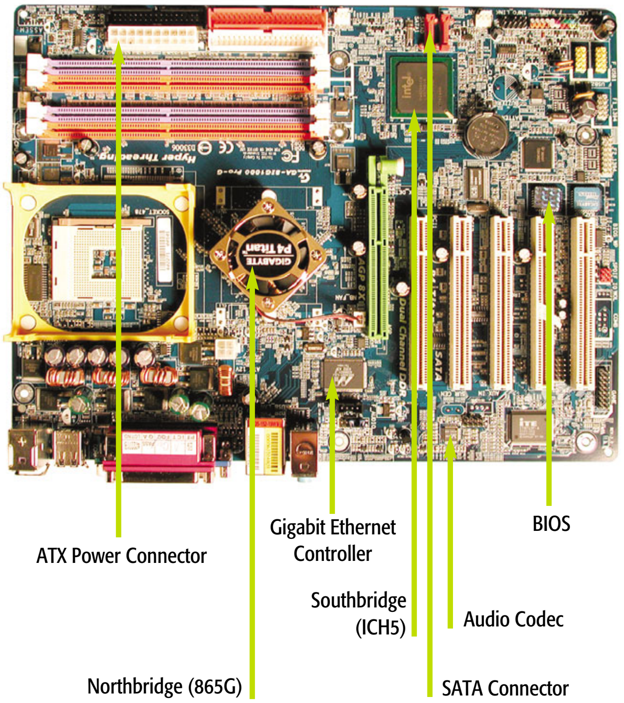
Overclock

Of course, what good is all that chrome if the engine itself is lacking. Although we've been pleasantly surprised by the performance of some 865G boards, we've been consistently disappointed by their overclocking performance. Before we even begin to look at overclocking the GA-8IG1000 Pro-G, however, we need to take some preliminary benchmarks.

Compared to the 3.2GHz Extreme Edition on the ASUS P4G800-V, the GA-8IG1000 Pro-G motherboard flat out smokes. At the default speed of 3.4GHz, our Extreme Edition managed a 3Dmark03 score of 6654, 343 points higher than the 3.2GHz on the ASUS board. The faster processor, of course, makes up some of that performance increase. Nonetheless, a 343-point increase in

3.4GHz Pentium 4 Extreme Edition Gigabyte GA-8IG1000 Pro-G

	Processor Speed	FSB	Multiplier	Voltage	Processor Temp	Case Temp	3Dmark03	PCMark04	PCMark04 CPU	PCMark04 Memory	PCMark04 Graphics	PCMark04 HDD
Stock Performance	3.4GHz	200MHz	17	1.55	42	30	6654	5469	5171	5110	5673	4259
Overclocked Performance	3.85GHz	225MHz	17	1.6	44.6	30.5	6719	5895	5830	5029	5720	4254

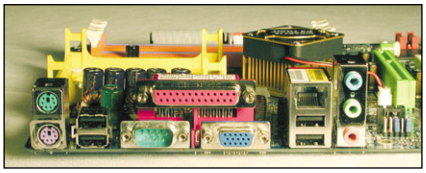


3Dmark03 is certainly significant. The move from a 3GHz Prescott to a 3.2GHz Prescott, for instance, only caused 3Dmark03 scores to rise a little more than 100 points on high-end Intel 875P motherboards.

PCMark04 scores were also significantly higher. The Overall PCMark04 score increased 230 points to 5469 while the CPU score increased 231 points from the scores posted by the 3.2GHz Extreme Edition on the ASUS 865G board. Despite the talk about Gigabyte's MIB technology, we didn't see a huge increase in the PCMark04 Memory score although we did note a slight increase from 5090 to 5110. The Graphics score also showed a very slight increase as it climbed from 5647 to 5673. The HDD score was virtually unchanged at 4259.

The 3.4GHz Extreme Edition does run a bit warmer than the 3.2GHz Extreme Edition. Our temperature probe measured a 42 degree Celsius temperature with the processor under load and an ambient case temperature of 30 C. By way of comparison, the 3.2GHz Extreme Edition measured 38.5 C under load. In the next two articles, however, temperatures fell back down to the 38 C range.

We were impressed with the GA-8IG1000 Pro-G's performance and features, but now it was time to see how well it overclocked. We rebooted the system and pressed the DELETE key during POST to access the setup utility. We then selected Frequency/Voltage Control from the main menu and changed Select CPU Host Control from Disabled to Enabled. This allowed us to adjust the CPU Host Frequency along with the AGP/PCI/SRC Fixed Settings. We were extremely impressed with the wide range of options offered by this motherboard. For instance, there were 32 different AGP/PCI/SRC Fixed settings to choose from. We left the setting at its default 66/33/100 value. There are also 66 different CPU Voltage settings to choose from.



The wide range of options and settings in the setup utility suggested Gigabyte gave some thought to overclockers. We selected CPU Host Frequency and increased the FSB from 200MHz to 210MHz. After saving our settings and rebooting the system, our processor was operating at 3.58GHz. The increased speed resulted in an even better 3Dmark03 score of 6696. We increased the FSB to 220MHz and managed a 6700 in 3Dmark03 with our processor running at 3.75GHz.

Overclock Comparison 3Dmark03

Chaintech S865PE	
Stock Performance	6631
Overclocked Performance	6800
★ Gigabyte GA-8IG1000 Pro-G	
Stock Performance	6654
Overclocked Performance	6719
MSI 875P Neo-FIS2R	
Stock Performance	6296
Overclocked Performance	6424

We started running into problems as we pushed the FSB to 230MHz. At that speed the processor was running at 3.91GHz and Windows continually rebooted. We had to decrease the FSB to 224MHz before we were able to get the system working again. With our processor running at 3.82GHz we managed a 6708 3Dmark03 score. Increasing the voltage from 1.55V to 1.60V helped stabilize the system at 225MHz (3.85GHz). We managed our best 3Dmark03 score of 6719 at this speed.

We also managed a successful overclock at 226MHz, but our 3.86GHz processor yielded a slightly lower 3Dmark03 score of 6705. Attempts to increase the voltage so we could push the processor's clock speed higher resulted in an unstable system.

We returned to a 225MHz FSB and a 3.85GHz processor speed then reran PCMark04. Scores had increased drastically from the baseline scores we recorded earlier. The Overall PCMark04 score increased more than 400 points to 5895 and the Processor score increased nearly 660 points to 5830. The Memory score, however, showed a slight decrease as it fell to 5029 while the Graphics score showed a modest improvement of 47 points to 5720. The HDD score, of course, remained largely unchanged at 4254.

Final Word

We were thoroughly impressed by Gigabyte's GA-8IG1000 Pro-G motherboard. Not only does it come with high-end features such as eight-channel audio and Gigabit Ethernet, but it also provides excellent performance and is actually one of the more overclockable boards we've seen in this roundup. OK, SATA RAID would make this great board even better, but we were certainly glad we saved this board for our last 865G motherboard. CPU

by Chad Denton

3.4GHz Pentium 4 Extreme Edition & Chaintech S865PE

For the first time in a long time, we came away impressed by an Intel 865G-based motherboard. The Gigabyte GA-8IG1000 Pro-G motherboard provided both performance and stability, but instead of looking forward to moving on, we found ourselves wondering if there was any way to improve. Luckily, we have a Chaintech 865PE motherboard up next.

System Specs

Processor, Motherboard & Drivers	
Processor	3.4GHz Pentium 4 Extreme Edition
Motherboard	Chaintech S865PE
BIOS Manufacturer	Phoenix-Award
BIOS Version	S865PE
Chipset Driver	4.20.1009
Common Components	
RAM	DDR SDRAM (2 x 512MB)
Video	Gainward PowerPack! Ultra/1800 XP Golden Sample (GeForce FX 5950 Ultra)
Hard Drive	80GB Western Digital WD800JD 7,200rpm SATA
Heatsink	Thermalright SLK-948U
CPU Fan	pcToys 92mm Tornado
CD-ROM	LiteOn Black 48X/24X/48X/16X DVD/CD-RW
Floppy	Samsung 1.44MB
Power Supply	Antec 430W TruePower
Case	Antec PLUS1080AMG
Temperature Monitor	MacPower Digital Doc 5

Motherboard

Chaintech has a reputation among enthusiasts for its performance-oriented and stable motherboards. We've looked at the Chaintech 9CJS Zenith a couple of times already and came away impressed. Unlike the Zenith board, the S865PE does without some of the extras (such as the CBOX3 and remote control included with the Zenith board), but as you'll see, it still delivers where it counts.

The 865PE chipset supports FSB speeds as fast as 800MHz and can support as much as 4GB of dual channel PC3200 DDR SDRAM. On the S865PE, however, Chaintech only includes two DDR SDRAM slots. That means that although the chipset supports 4GB of memory, the motherboard itself only supports 2GB.

3.4GHz Pentium 4 Extreme Edition Chaintech S865PE

	Processor Speed	FSB	Multiplier	Voltage	Processor Temp	Case Temp	3Dmark03	PCMark04	PCMark04 CPU	PCMark04 Memory	PCMark04 Graphics	PCMark04 HDD
Stock Performance	3.4GHz	200MHz	17	N/A	38.2	27.7	6631	5567	5238	5286	5694	4292
Overclocked Performance	3.69GHz	214MHz	17	N/A	40.4	29	6800	6048	5499	5654	5657	4289

Chaintech chose to pair the 865PE on the northbridge with an Intel ICH5 on the southbridge. The ICH5 supports two SATA 150 drives, up to four UDMA 100 devices, and up to eight USB 2.0 ports. The Chaintech Zenith board we looked at earlier used an Intel ICH5R chip on the southbridge to provide RAID 0 or 1 support on SATA drives, but on this board Chaintech opted for the standard ICH5.

Additionally, the S865PE also includes an integrated AC'97 audio codec that supports six-channel audio and a Realtek 8101L 10/100 Ethernet controller. Again, neither of these options are as impressive as the eight-channel audio and Gigabit Ethernet found on the Chaintech Zenith board, but neither option is subpar. The motherboard includes one 1.5V 4X/8X AGP slot and five PCI slots, which should provide most users with plenty of room for expansion.

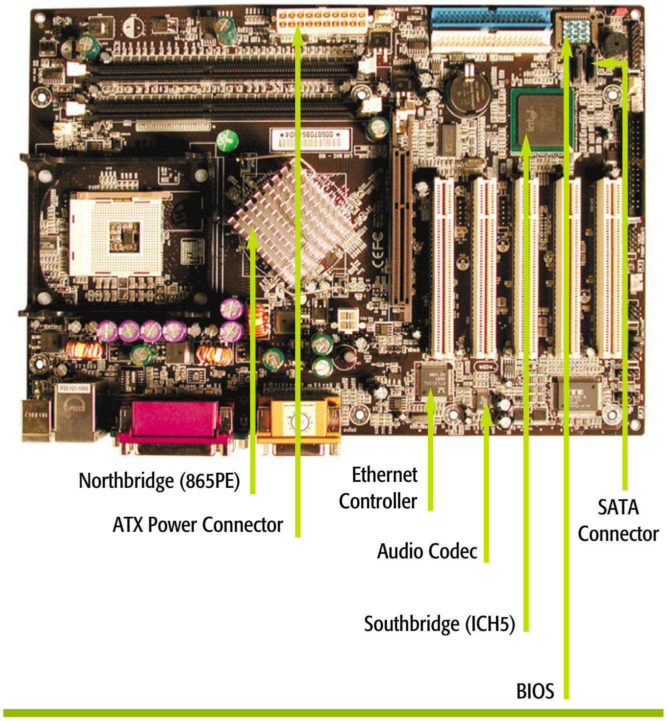
Overclock

The Chaintech 9CJS Zenith board we looked at earlier provided excellent overclocking performance and managed to provide some standout scores relative to other boards. We were hopeful this 865PE version would provide similar capabilities.

Our default benchmark scores were impressive all the way around. Our 6631 3Dmark03 score was slightly lower than the 6654 default 3Dmark03 score we posted in our last article, but generally speaking it's a much better score than we typically see and it bested the highest 3Dmark03 score posted by our 875P motherboard in the next article.

PCMark04 scores were also impressive. The 5567 Overall PCMark04 score was the highest default Overall PCMark04 score we posted as was the 5238 CPU score. The Chaintech Zenith board we looked at earlier seemed to provide excellent PCMark04 Memory scores and the S865PE followed suit with a 5286 Memory score. Even the 5694 Graphics score was the best default score of any motherboard/processor combination in this series of reviews. The HDD score, on the other hand, hovered near the 4300 mark that most systems seemed to average.

Under load, we recorded a 38.2 degree Celsius processor temperature and a 27.7 C ambient case temperature. This temperature was similar to temperatures posted by the 3.2GHz Extreme Edition and cooler than the 42 C

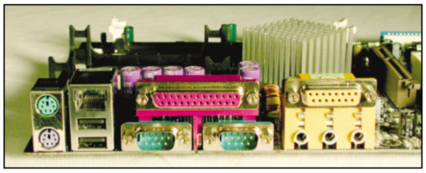


processor temperature reported in our last article. Temperatures were similar under load in the next article, which suggest that the higher 42 C temperature in our previous article may be an anomaly.

After recording our temperatures, we rebooted the system and pressed DELETE during POST to enter the setup utility. We selected Frequency/Voltage Control from the main menu and immediately noticed there was no option to adjust the CPU voltage. This was a little disappointing as it's often necessary to increase the processor's voltage in order to make it stable at higher clock speeds. We did manage to increase the FSB from 200MHz to 210MHz by selecting CPU Clock and using PAGE UP and PAGE DOWN. After saving our settings and rebooting the system, our 3.4GHz Extreme Edition was running at 3.62GHz.

We saw a modest 3Dmark03 improvement as our score increased to 6697. Increasing the FSB an additional 10MHz to 220MHz, however, prevented the system from booting properly. Decreasing the FSB to 215MHz caused Windows to reboot, but at least we seemed to be moving in the right direction. Setting the FSB to 214MHz set the processor's clock speed at 3.69GHz. The system was not only stable at this speed, it provided us with the best 3Dmark03 score we saw throughout this entire roundup of Intel processors at 6800.

Not being able to increase our processor's core voltage means the S865PE won't let you overclock as far as its 875P-based Zenith counterpart, but the 3Dmark03 score was certainly impressive. PCMark04 scores were also impressive. The 6048 Overall PCMark04 was the best PCMark04 score posted on the Intel side of this roundup as was the 5654 Memory score. The 5499 CPU score and 5657 Graphics scores were still impressive although we were able to top those scores with the 875P motherboard in our next article. As always, the 4289 HDD score was roughly the same as scores we've seen throughout this roundup.



Although the Chaintech S865PE lacked the ability to adjust the processor's voltage, we hit the same speed limitation with the S865PE and the 3.4GHz Extreme Edition that we hit with the 3.2GHz Extreme Edition and the Chaintech 875P-based 9CJS Zenith. Both processors topped out at 3.68GHz and 3.69GHz respectively, but the Zenith board's 3Dmark03 scores started to plummet as we increased the speed past the 3.65GHz mark. Naturally, the 3.2GHz Extreme Edition showed more improvement in PCMark04 because its speed increased more.

Although we managed to get the same 3.4GHz processor up to 3.85GHz in the last case study, we saw higher performance scores from our Chaintech board. The 5720 PCMark04 Graphics score in our last article was better than the 5657 score we posted here. Aside from the Graphics score, however, the Chaintech board provided better scores across the board including an 81-point better 3Dmark03 score with a processor that was running 160MHz slower.

Overclock Comparison 3Dmark03

★ Chaintech S865PE	
Stock Performance	6631
Overclocked Performance	6800
Gigabyte GA-8IG1000 Pro-G	
Stock Performance	6654
Overclocked Performance	6719
MSI 875P Neo-FIS2R	
Stock Performance	6296
Overclocked Performance	6424

We did see a slight increase in temperature as speeds increased. At 3.69GHz, our 3.4GHz Extreme Edition's temperature rose 2.2 degrees to 40.4 C. The ambient case temperature increased 1.3 degrees to 29 C. Even these temperatures were well below the 42 C default temperature we recorded in our last article. At the maximum overclocked speed, temperatures in our previous article hit 44.3 C, 3.9 degrees warmer than the highest temperature we recorded here.

Final Word

We were disappointed that we couldn't overclock the 3.4GHz Extreme Edition quite as far on the Chaintech as we managed in our last article. We would love to see what kind of scores we could achieve on the Chaintech board with the processor running at 3.85GHz. In terms of performance, however, the Chaintech S865PE more than delivered. Although we achieved faster FSB and processor speeds on the Gigabyte board in our last article, almost all the scores from the Chaintech board eclipsed scores from the Gigabyte board.

by Chad Denton

3.4GHz EXTREME EDITION & MSI 875P NEO-FIS2R

System Specs

Processor, Motherboard & Drivers	
Processor	3.4GHz Pentium 4 Extreme Edition
Motherboard	MSI 875P NEO-FIS2R
BIOS Manufacturer	AMI
BIOS Version	3.31a
Chipset Driver	6.00.1014
Common Components	
RAM	DDR SDRAM (2 x 512MB)
Video	Gainward PowerPack! Ultra/1800 XP Golden Sample (GeForce FX 5950 Ultra)
Hard Drive	80GB Western Digital WD800JD 7,200rpm SATA
Heatsink	Thermalright SLK-948U
CPU Fan	pcToys 92mm Tornado
CD-ROM	LiteOn Black 48X/24X/48X/16X DVD/CD-RW
Floppy	Samsung 1.44MB
Power Supply	Antec 430W TruePower
Case	Antec PLUS1080AMG
Temperature Monitor	MacPower Digital Doc 5

So far we've reviewed 11 different motherboard and processor combinations, starting with the Intel 3E GHz Pentium 4, based on Intel's new Prescott core, on up to the pricey 3.4GHz Pentium 4 Extreme Edition. Now we finish the series by pairing the 3.4GHz Pentium 4 Extreme Edition with MSI's 875P-based NEO-FIS2R. As you'll see, the MSI motherboard fell somewhere between the Gigabyte GA-8IG1000 Pro-G and the Chaintech S865PE in both performance and pure overclocking ability.

Motherboard

The MSI 875P NEO-FIS2R uses Intel's high-end (aka expensive) 875P chipset. The 875P's primary claim to fame is support for PAT (Performance Acceleration Technology). According to Intel, PAT uses more aggressive memory timings to reduce memory latency and improve performance. In addition to PAT, the 875P also supports ECC memory, making it a more attractive board for workstations and servers. Aside from PAT and ECC support, the 875P is fairly similar to Intel's less expensive 865PE. Both chipsets support FSB speeds as fast as 800MHz, up to 4GB of dual-channel PC3200 DDR SDRAM, and 8X AGP.

Complementing the 875P is Intel's ICH5R on the southbridge. The ICH5R provides the same support for dual SATA 150 drives, but adds support for RAID levels 0 or 1. The ICH5R also supports up to eight USB 2.0 ports and standard ATA devices such as optical drives or IDE hard drives. The ICH5R, however, doesn't support multilevel RAID, such as RAID 0+1. A Promise 20378 RAID controller and two additional SATA connectors, however, provide support for RAID 0+1. The Promise RAID controller also supports RAID on the yellow colored IDE connector.

It's almost impossible to find a motherboard that doesn't include onboard audio and Ethernet. MSI included an AC'97 audio codec that supports 5.1 surround sound. The motherboard does support SPDIF out, but only through an included S-bracket that connects to the back of the case. Ethernet connectivity comes via an Intel 82547EI Gigabit Ethernet controller.

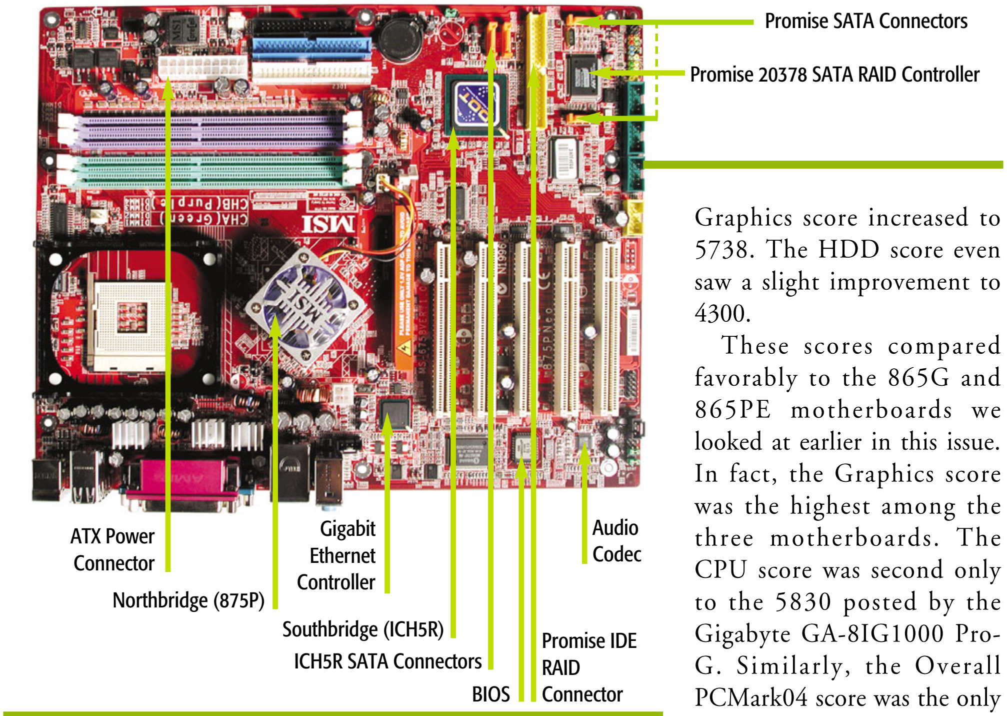
Overclock

The MSI 875P NEO-FIS2R has plenty of features, but what we were really interested in was whether or not this motherboard could provide the kind of performance we saw from the Chaintech S865PE or the overclocking ability of the Gigabyte GA-8IG1000 Pro-G.

We started off taking our default scores, as usual. We were immediately disappointed by the 6296 3Dmark03 score. It was a far cry from the 6631 score posted by the same processor on the Chaintech S865PE motherboard, and it wasn't nearly as good as the 6654 3Dmark03 score posted by the same processor on the Gigabyte 865G motherboard. PCMark04 scores were also lower than in our previous articles. The 5431 Overall PCMark04 score was lower than the 5567 Overall score we got originally on the 865PE motherboard and the 5469 Overall score we received from the 865G motherboard. We were also disappointed in the 5034 CPU score. Despite the 875P's support for PAT, the 5055 Memory score was the lowest default score we recorded with our 3.4GHz Extreme Edition. The 5664 Graphics score was also the lowest, although it wasn't too far behind the 5673 Graphics score posted on the 865G and the 5694 score posted on the 865PE motherboards. The 4274 HDD score was lower than the 4292 HDD score posted by the 865PE, but it was faster than the 4259 HDD score posted by the Gigabyte board.

3.4GHz Pentium 4 Extreme Edition
MSI 875P NEO-FIS2R

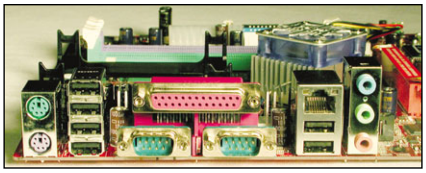
	Processor Speed	FSB	Multiplier	Voltage	Processor Temp	Case Temp	3Dmark03	PCMark04	PCMark04 CPU	PCMark04 Memory	PCMark04 Graphics	PCMark04 HDD
Stock Performance	3.40GHz	200MHz	17	1.48	37.3	29.9	6296	5431	5034	5055	5664	4274
Overclocked Performance	3.76GHz	221MHz	17	1.48	38.4	30.4	6424	6018	5697	5599	5738	4300



Our processor temperature probe recorded a 37.3 degree Celsius temperature under load, which was one of the coolest readings we recorded for the 3.4GHz Extreme Edition. The ambient case temperature was just below the 30 C mark at 29.9 C, which was similar to case temperature measurements in our past two articles.

After recording our default scores, we began to overclock the motherboard. We pressed DELETE to enter the system setup and then selected Frequency/Voltage Control from the main menu. We selected Adjust CPU Bus Clock (MHz) and increased the value from 200MHz to 210MHz. This increased our processor's clock speed to 3.57GHz and increased our 3Dmark03 score 68 points to 6364. We were easily able to increase the FSB another 10MHz to 220MHz. Our 3.77GHz processor posted a 6406 3Dmark03 score, up 42 points from our previous score.

We tried increasing the FSB another 10MHz, but with the processor running at 3.91GHz, our system refused to boot. We split the difference and set our FSB to 225MHz. At this speed, Windows booted up and then promptly rebooted. Decreasing the FSB another 2MHz didn't seem to help the problem. We continued to drop the FSB, setting it at 222MHz, but Windows still continued to reboot. Finally, at 221MHz, we were able to get the system to boot properly. This 1MHz increase from our last stable overclock provided an 18-point increase in 3Dmark03.



Increasing the FSB is one way to stabilize a system at higher clock speeds, but unfortunately it didn't quite do the job for us in this case. One item of interest, however, is the unique color-coded voltage selections on the MSI board. As you begin to increase voltages in the setup utility, colors change from white to yellow. If you continue to increase the voltage, settings turn red to indicate that the voltage may be more than a specific component can handle. The color codes, however, are just suggestions. If you think you know what you're doing, you can increase voltages into the red.

We left our FSB at 221MHz and reran PCMark04. The Overall PCMark04 score increased almost 600 points to 6018, while the CPU score increased more than 600 points to 5697. The Memory score increased to 5599, and the Graphics score increased to 5738. The HDD score even saw a slight improvement to 4300.

Overclock Comparison 3Dmark03

Chaintech S865PE	
Stock Performance	6631
Overclocked Performance	6800
Gigabyte GA-8IG1000 Pro-G	
Stock Performance	6654
Overclocked Performance	6719
★ MSI 875P Neo-FIS2R	
Stock Performance	6296
Overclocked Performance	6424

These scores compared favorably to the 865G and 865PE motherboards we looked at earlier in this issue. In fact, the Graphics score was the highest among the three motherboards. The CPU score was second only to the 5830 posted by the Gigabyte GA-8IG1000 Pro-G. Similarly, the Overall PCMark04 score was the only other score above the 6000 mark, but the 6048 posted by the Chaintech S865PE beat it out by just 30 points.

In earlier case studies, we tested the 3.2GHz Extreme Edition with the Chaintech 9CJS Zenith. For the most part, the faster processor we used in this article helped the MSI board secure better benchmarks than our 3.2GHz/Chaintech combo. The Zenith board, however, still delivered a better Memory score in PCMark04 and a better 3Dmark03 score than the MSI did with a faster processor.

Final Word

After all our tweaking and fiddling for this particular case study was completed, we decided the MSI 875P motherboard walked the middle ground between the Chaintech and Gigabyte motherboards we reviewed earlier. Performance scores, for the most part, fell short of the Chaintech motherboard we looked at previously, but a few benchmark scores managed to stand out, including the PCMark04 Graphics score.

by Chad Denton

AMD ATHLON 64 3000+ & ABIT KV8-MAX3

If you read our first *PC Modder* issue late last year, you already know that we lined up 10 AMD Athlon XP processors (XP 2000+ through XP 3200+) and then overclocked them to their limits. With this issue, we're focusing on AMD's Athlon 64 and matching each of several versions of the CPU with multiple chipsets. Despite having the lowest speed rating of our non-FX Athlon 64 trio, the Athlon 64 3000+ isn't the oldest processor we highlight in this issue. In fact, AMD released the Athlon 64 3200+ before launching the 3000+. The 3000+ is the only processor in our lineup that has a NewCastle core, and at $213, it is also the least-expensive processor we overclocked.

Even so, the 3000+ is no slouch. It boasts a 2GHz clock speed, a 128KB L1 cache (a 64KB instruction cache and a 64KB data cache), and a 512KB L2 cache. Unlike the Athlon XP's frontside bus architecture, the 3000+ has a 1.6GHz HyperTransport. AMD used its 0.13-micron process to produce the core, which boasts MMX, SSE, SSE2, 3DNOW!, and 3DNOW!+ instruction sets. AMD recommends a max CPU case (which covers the core of the chip) temperature of 70 degrees Celsius.

System Specs

Processor, Motherboard & Drivers	
Processor	AMD Athlon 64 3000+
Motherboard	ABIT KV8-MAX3
BIOS Manufacturer	Phoenix
BIOS Version	V6.00PG (ABIT Version 16)
Chipset Driver	VIA 4.51 (K8T800)
Common Components	
RAM	DDR SDRAM (2 x 512MB)
Video	Gainward PowerPack! Ultra/ 1800 XP Golden Sample (GeForce FX 5950 Ultra)
Hard Drive	80GB Western Digital WD800JD 7,200rpm SATA
Heatsink	Thermalright SLK-948U
CPU Fan	pcToys 92mm Tornado
CD-ROM	LiteOn Black 48X/24X/48X/16X DVD/CD-RW
Floppy	Samsung 1.44MB
Power Supply	Antec 430W TruePower
Case	Antec PLUS1080AMG
Temperature Monitor	MacPower Digital Doc 5

AMD Athlon 64 3000+ (NewCastle) ABIT KV8-MAX3

	Processor Speed	FSB	Multiplier	Voltage	Processor Temp	Case Temp	3Dmark03	PCMark04	PCMark04 CPU	PCMark04 Memory	PCMark04 Graphics	PCMark04 HDD
Stock Performance	2.04GHz	204MHz	10	1.5	33.4	29.9	6154	4110	3813	3643	5191	4779
Overclocked Performance	2.18GHz	218MHz	10	1.65	34.3	27.2	6243	4386	4122	3886	5273	4691

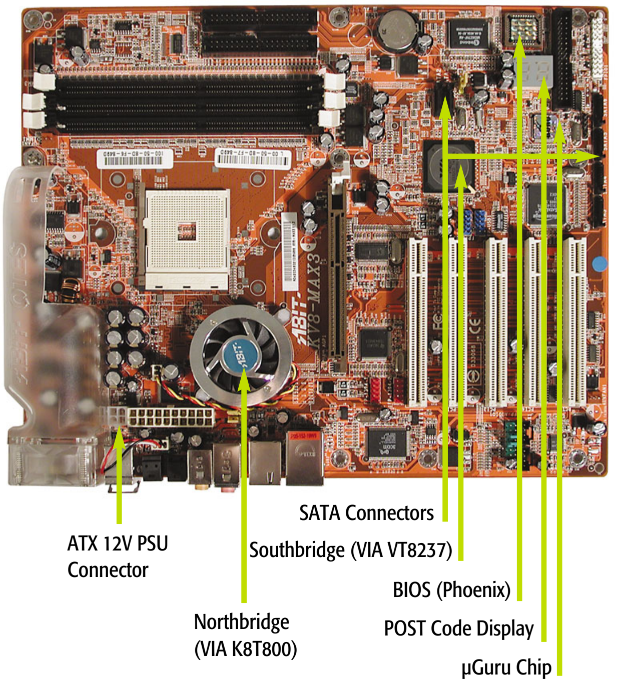
Motherboard

The first thing we noticed when we opened the ABIT KV8-MAX3's box is that it is loaded to the gills with extras, and it's no small box. We discovered similar goodies when we rifled through the other AMD Athlon 64-based motherboard boxes (the Chaintech Zenith ZNF3-150 even includes a card reader). Whereas the AMD Athlon XP-based boards we reviewed for the last *PC Modder* included the occasional USB D-bracket, several of these boards boast multiple D-brackets, free programs, and other extras.

We weren't surprised that the Deluxe version includes two SATA PSU adapter cables (two HDD connectors each) and four SATA data cables, which are standard issue anymore. The CPU socket mount isn't installed but you can attach it to the mobo easily enough. ABIT threw in a D-bracket that houses two USB 2.0 ports, a mini-B USB port, and a single FireWire port. We're glad to see all of these features on a single bracket, which means you'll need to sacrifice only one PCI slot. If your video card eats up a second slot already, you may try to save space by sneaking the D-bracket into that second slot. We dropped all the goodies and manuals when we saw the KV8-MAX3's coolest extra: Secure IDE.

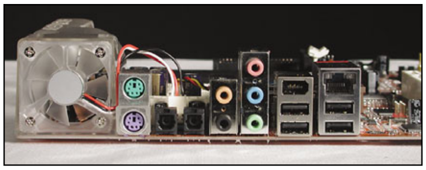
ABIT partnered with Nova to offer Secure IDE, which features Nova's X-Wall LX-40 encryption chip. The chip stands on a small PCB that also houses two IDE interfaces, a 4-pin power interface (the KV8-MAX3 includes an extra PSU adapter that has one of these connectors), and some jumpers that let you select your primary or secondary drive. You can encrypt a single hard drive (the X-Wall chip uses 40-bit DES encryption) by running one IDE cable from the motherboard to the chip and another IDE cable from the chip to the hard drive. Once you install the chip, you can access your computer only by inserting a special USB key into the device's USB cable, which extends from the chip through a D-bracket. Don't install the Secure IDE device if you're using the KV8-MAX3 to upgrade a PC; the device automatically wipes the hard drive before encrypting it. ABIT claims that the Secure IDE device offers 1.6Gbps throughput and doesn't impact the CPU or system memory, but we decided not to use this feature anyway—we're gunnin' for speed, not security.

The KV8-MAX3 includes a SATA driver floppy disk and a driver CD. Aside from Adobe Acrobat Reader 5.0, the package doesn't have any third-party software, but it does include ABIT's new Windows-friendly µGuru utility suite. New users will like µGuru's Magical Black Box utility, which emails information about system



problems to ABIT's tech support, meaning you won't need to write a long email explaining your system configuration and problems when you contact tech support. Hardware Guru is a zero-impact monitoring utility that displays your processor's temp and other vital statistics in real-time, which means you can keep an eye on your system's health when you are stressing the system (instead of entering the BIOS and guesstimating how your PC will perform under stress).

Of course, the most important component of the µGuru suite (at least as far as we're concerned), is the OC Guru utility. Unlike most motherboard overclocking utilities, which sport outlandish (and often confusing) interfaces, ABIT's OC Guru has a remarkably simple interface that lets you get in, overclock, and get back out without wasting time fumbling through oddly-shaped buttons and tabs. OC Guru has only two tabs: Turbo Mode and F1 Mode. Turbo Mode has a single slider bar that lets you quickly bump up the processor's clock speed. It also displays your processor's info. If you're new to overclocking, you can use Turbo Mode to boost your benchmarks without running a large risk. If you want to go the extra mile, switch to F1 mode, which adds CPU, AGP, and DDR (RAM) voltage tools to the mix. Your system returns to its default settings when the PC reboots, which means you can recover from crashes by simply powering on your PC again (unless your system is a smoldering lump, that is). We were glad to see that you won't need to inch your system back into its previously overclocked state every time you reboot your PC; the OC Guru lets you save multiple overclocked settings. For example, you can surf the Internet at the system's default settings, then open OC Guru, load the saved overclocked settings, and then dive into Counter-Strike. When you're done playing, you can easily return the system to its original state. Welcome to the beauty of on-demand overclocking.



Despite the massive OTES (Outside Thermal Exhaust System) vent, the CPU socket area has plenty of space. The OTES vent, which covers several of the board's Rubycon capacitors, channels some air away from the heatsink and out the back of the case, thanks to a tiny fan that sits just above the PS/2 ports. The mobo spots six SATA connectors, a VIA K8T800 northbridge, a VT8237 southbridge, and a POST Code Display, which displays dozens of error codes.

Overclock Comparison 3Dmark03

Chaintech Zenith ZNF3-150	
Stock Performance	6150
Overclocked Performance	6253
★ ABIT KV8-MAX3	
Stock Performance	6154
Overclocked Performance	6243
Jetway S755MAX	
Stock Performance	6126
Overclocked Performance	6241

Overclocking

We weren't surprised to find that the Phoenix Award BIOS V.6 (ABIT Version 16) didn't let us adjust the multiplier from the default 10. The BIOS had plenty of standard OC options, including a wide VCore voltage range: you can push your processor up to a whopping 1.85V if you so choose. You can also change the AGP voltage (1.5V to 1.65V) and the DRAM voltage (2.5V to 3.2V).

The BIOS' OC On The Fly feature lets you apply changes without rebooting. We're not sure we like this feature; successfully applying overclocked settings in the BIOS doesn't guarantee that the system can handle the stress when it loads Windows. As a result, some users may unknowingly push their PCs too far. Overclocking is a painstaking, often frustrating (but ultimately rewarding) process; we're always wary of shortcuts.

Despite the board's feature-laden overclocking section, we didn't break any records. In fact, the KV8-MAX3 couldn't beat out any of the other two boards in our lineup. The system crashed at 2.16GHz with default voltage (1.5V), so we nudged the voltage to 1.6V and tried again. We upped the system 1MHz without any trouble, but it crashed again at 2.18GHz. Eventually, we coaxed our PC to 2.22GHz with the voltage at 1.7V, but the system refused to post decent benchmark scores. At 2.18GHz with a 1.65V VCore, the system posted its best 3Dmark03 score: 6243.

Final Word

Overall, we like this board. It has plenty of SATA connectors, a unique cooling system, and a solid utility suite. It's important to note that although the board didn't take clock speed bragging rights, it posted strong benchmark scores. Also, the µGuru utility's OC Guru feature lets casual overclockers pump up the volume before playing games or opening intensive applications.

by Joshua Gulick

AMD Athlon 64 3000+ & Chaintech Zenith ZNF3-150

As with the ABIT KV8-MAX3 and the Jetway S755MAX, we plugged an AMD Athlon XP 3000+ into the Chaintech Zenith ZNF3-150. At $156, it is the most expensive motherboard in our lineup, but it doesn't approach Athlon 64 FX-based motherboard prices.

Motherboard

Chaintech didn't pull any punches when it threw extras into the ZNF3-150's box. The package includes the important basics: four SATA cables (all of which have dust caps, which is a nice touch), two SATA PSU adapters (for a total of four hard drive connectors), a small tube of thermal paste, two bright-orange, rounded IDE cables, and a rounded floppy cable. Chaintech also tossed in a screwdriver that resembles a highlighter. You can break down the screwdriver into four separate screwdriver heads, including two Philips-head pieces and two flat-head pieces, all of which should cover most of your system's half-million screws. We also liked the CMC (Chaintech Multimedia Card), which attaches to the motherboard via a small, PCI-slot-like connector at the bottom of the board. As with a standard PCI card, the CMC extends to the back of the computer, exposing two FireWire ports, an SPDIF-out port, and connectors for bass and center cables. The card also has two internal CD-ROM audio-in connectors that let you connect your CD-ROM to the card. The card complements the motherboard riser's three standard audio ports.

Those extras spice up the package, but Chaintech took the goodies-madness one giant step further: the ZNF3-150 includes Chaintech's CBOX3, which is a media card reader that fills a 5.25-inch bay. The reader supports CF, Micro Drive, MMC, MS SDC, and SMC cards and houses two USB 1.1 ports, a mic port, and a headset port. The card reader also includes a small, blue LED that displays the system's temp (and, if your system is in trouble, error codes). Of course, Chaintech didn't want to throw off your PC's color scheme, so it included black, beige, and gray card reader faceplates.

The motherboard has a few of its own notable features. The Chaintech RadEX (Revolutionary Active Direct Exhaust) system, which includes a tiny fan and several aluminum fins, surrounds the mobo riser and channels heat away from the processor and capacitors. Chaintech lined up the capacitors alongside the L-shaped RadEX, but left a gap in front of the fan, which creates a clear path from the processor area to the fan. A long, fluid-filled heatpipe is inside the RadEX system, sucking up heat and transferring it to the aluminum fins. We couldn't see the heatpipe, so after we overclocked the board we detached the RadEX device and looked under the hood. Sure enough, a copper runs the length of the device. The RadEX isn't the largest onboard cooling system we've seen, but it doesn't eat up much motherboard space, and the copper heatpipe/aluminum fin combo can't hurt.

The ZNF3-150 has three fan speed monitor connectors that let you keep an eye on your CPU, system, and chipset. Chaintech placed the CMOS jumper near one of the three IDE connectors, which means you easily reach in to grab the jumper without bumping anything important. You'll have a tougher time snagging the Keyboard/Mouse Power On jumper because it tucks between the RadEX system and your PSU, but you'll only need to change it once, if at all. When the jumper is in the 2-3 position (bottom two pins), you can use a PS/2

System Specs

Processor, Motherboard & Drivers	
Processor	AMD Athlon 64 3000+
Motherboard	Chaintech Zenith ZNF3-150
BIOS Manufacturer	Phoenix
BIOS Version	V6.00PG (Chaintech Version 3)
Chipset Driver	NVIDIA v3.13 (nForce3 150)
Common Components	
RAM	DDR SDRAM (2 x 512MB)
Video	Gainward PowerPack! Ultra/1800 XP Golden Sample (GeForce FX 5950 Ultra)
Hard Drive	80GB Western Digital WD800JD 7,200rpm SATA
Heatsink	Thermalright SLK-948U
CPU Fan	pcToys 92mm Tornado
CD-ROM	LiteOn Black 48X/24X/48X/16X DVD/CD-RW
Floppy	Samsung 1.44MB
Power Supply	Antec 430W TruePower
Case	Antec PLUS1080AMG
Temperature Monitor	MacPower Digital Doc 5

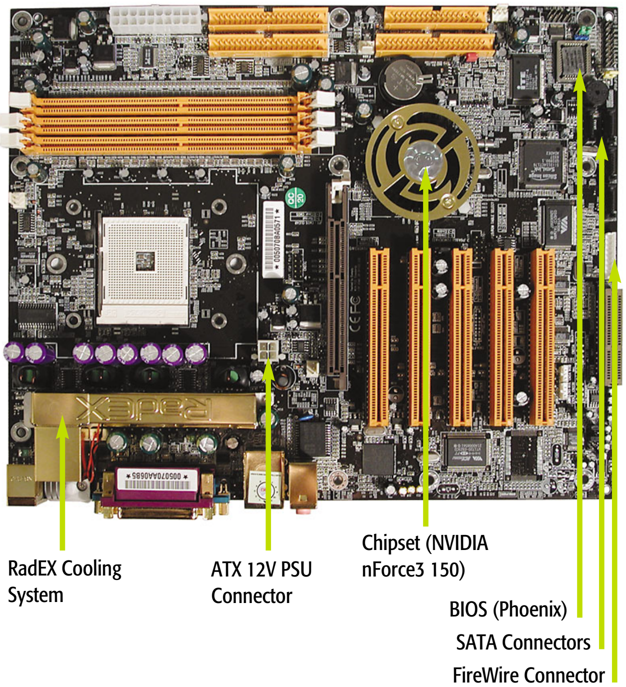
AMD Athlon 64 3000+ (NewCastle) Chaintech Zenith ZNF3-150

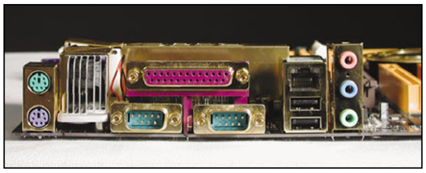
	Processor Speed	FSB	Multiplier	Voltage	Processor Temp	Case Temp	3Dmark03	PCMark04	PCMark04 CPU	PCMark04 Memory	PCMark04 Graphics	PCMark04 HDD
Stock Performance	3GHz	200MHz	10	1.5	34.2	29.3	6150	4027	3737	3565	5481	4613
Overclocked Performance	2.24GHz	224MHz	10	1.65	39.1	29.7	6253	4453	4222	3978	5605	4624

keyboard or mouse to power on your system. The board also has a jumper that lets you use a USB keyboard or mouse. It's a minor feature, but if you put your computer under your desk, you'll probably like turning on your computer with the press of a key.

Thanks to the nForce3 150 chipset, the ZNF3-150 supports up to six USB 2.0 ports. The riser includes two external ports and the card reader essentially converts two of the ports to USB 1.1. We hate to choke fast ports, but hey, the card reader is free. We like the Gigabit LAN port and the onboard audio, which supports 7.1 channels. The three memory sockets support up to 2GB of DDR 266MHz, 333MHz, or 400MHz RAM.

The ZNF3-150 doesn't include any overclocking software, but it does offer three PC protection-related programs: Symantec Norton AntiVirus 2003, Wasay Image It 3.0, and Wasay Pro Magic 6.0. If you run Windows XP, you probably won't need Pro Magic, which acts as an instant recovery tool, complete with Restore Points, but you'll probably like Image It, which lets you create a backup image of your system before you overclock. Norton AntiVirus 2003 isn't the latest version of Symantec's antivirus software, but again, free is free.





Overclocking

As with ABIT, Chaintech modified its BIOS. We booted our system, entered the Phoenix Award BIOS V.6.00PG (Chaintech Version 3) and then browsed the system's overclocking features. The first thing we noticed is that the board's CPU VCore voltage feature only supports up to 1.7V, 1.5V less than the ABIT KV8-MAX3. Although 1.7V is a respectable voltage, we expect overclocking-friendly boards to have plenty of juice. After all, if your system is just barely unstable (crashing only when running the most intensive applications, for example), being able to add a little more voltage just might tip the scales in your favor.

The BIOS doesn't let users adjust individual memory timings, but it does have 100MHz to 200MHz memory frequency settings. You can also adjust the AGP voltage (1.5V to 2.2V), DRAM voltage (2.6V to 2.9V), and chipset voltage (1.7V to 1.9V). We like the PC Health Status section, which displays relevant fan speeds and voltages. If you're particularly worried about melting your system, you can activate the Shutdown Temperature option and then specify the appropriate temp, but keep in mind that your system will generate plenty of heat when you overclock it. At any rate, our Digital Doc 5 never displayed a temperature over 41.2 degrees Celsius, but we can safely assume that the processor case's actual temp was hotter, as we attached our sensor to the side of the CPU case. Overall the ZNF3-150 was our hottest board; both the CPU temp and the system chassis temp hovered about five degrees above our other two boards.

Overclock Comparison 3Dmark03

★ Chaintech Zenith ZNF3-150	
Stock Performance	6150
Overclocked Performance	6253
ABIT KV8-MAX3	
Stock Performance	6154
Overclocked Performance	6243
Jetway S755MAX	
Stock Performance	6126
Overclocked Performance	6241

Unlike the KV8-MAX3, which required extra voltage almost right away, the ZNF3-150 coasted on 1.5V until it hit 2.19GHz. Despite the 1.7V CPU VCore ceiling, the ZNF3-150 eked out a 2MHz lead over the KV8-MAX3 at 2.24GHz (with a 1.65V VCore, no less), tying the Jetway S755MAX. Both boards posted similar benchmark scores. At 6253 3Dmarks, the motherboard posted the top 3Dmark03 score of our three-board lineup, but it posted an overall score of 4453 in PCMark04, 28 points shy of the S755MAX's top score.

We tried to push the processor beyond 2.24GHz, but the system was unstable at higher clock speeds, even when we pushed the voltage to 1.7V. The system booted at 2.23GHz with a 1.7V VCore, but it posted low benchmark scores.

Final Word

We were surprised to find that, despite packing the box with extras, Chaintech didn't add a SATA driver floppy, which meant we had to use a different computer to create the necessary floppy. Aside from that minor gripe and our beef with the BIOS VCore, we like this motherboard. It has truly useful extras and a strong onboard cooling system.

by Joshua Gulick

AMD Athlon 64 3000+ & Jetway S755MAX

At $89, the Jetway S755MAX is one of the least expensive boards in our lineup, so we weren't surprised to see a slim box and even slimmer component package. It's not uncommon to find AMD Athlon XP-based boards at this price, but Athlon 64 boards regularly break $100. The Jetway sports an SiS 755 northbridge and an SiS 9636L southbridge.

Motherboard

The S755MAX's box includes a single SATA cable, a driver CD, a SATA driver floppy, a thin users guide, a flat floppy cable, an IDE cable, and an audio port D-bracket that takes up a single PCI slot bay. Although we love the price, we'd like more extras in any package: namely, a second SATA cable and at least one SATA PSU adapter. Some power supplies still lack the newish connectors that power SATA hard drives, and if you buy an OEM hard drive, you probably won't receive one. That said, the box included one of the most important parts of any SATA-friendly motherboard: the SATA driver floppy.

AMD Athlon 64 3000+ (NewCastle)
Jetway S755MAX

	Processor Speed	FSB	Multiplier	Voltage	Processor Temp	Case Temp	3Dmark03	PCMark04	PCMark04 CPU	PCMark04 Memory	PCMark04 Graphics	PCMark04 HDD
Stock Performance	2GHz	200MHz	10	1.5	34	28.2	6126	4018	3718	3529	5574	4704
Overclocked Performance	2.24GHZ	224MHz	10	1.8	33.5	27.4	6241	4481	4213	3920	5712	4707

We also like the audio port D-bracket, but we wish it had a longer cable. The S755MAX's SPDIF connectors stand just behind the riser, which means that the cable travels under the AGP card to the PCI slots. Unfortunately, the short cable reaches only the first PCI slot, which means that extra-large video cards might contact the device's PCB. The short cable might also pull against and loosen the video card. The device sports Rear Out, Center, SPDIF Out, and SPDIF In ports, and complements the motherboard riser's standard audio ports.

The S755MAX doesn't include any extra printed materials, such as a poster that identifies onboard connectors, which means you'll need to refer to the slim, crowded users guide when you want to connect your chassis' front panel connectors. That said, the users guide includes decent instructions, dozens of black-and-white pictures and illustrations, and, most importantly, a one-page insert that includes instructions for installing SATA drivers. The guide also includes an excellent BIOS chapter that will let new overclockers quickly familiarize themselves with the BIOS' many sections.

We were glad to see that the mobo's CPU socket has plenty of room. We attached the included CPU socket bracket and installed our oversized heatsink without any trouble. The SiS 755 northbridge, which includes an aluminum heatsink, stands below the CPU socket, close to (but not crowding) the 8X AGP slot. The northbridge includes a fan connector. The SiS 936L southbridge sits just behind the PCI slots.

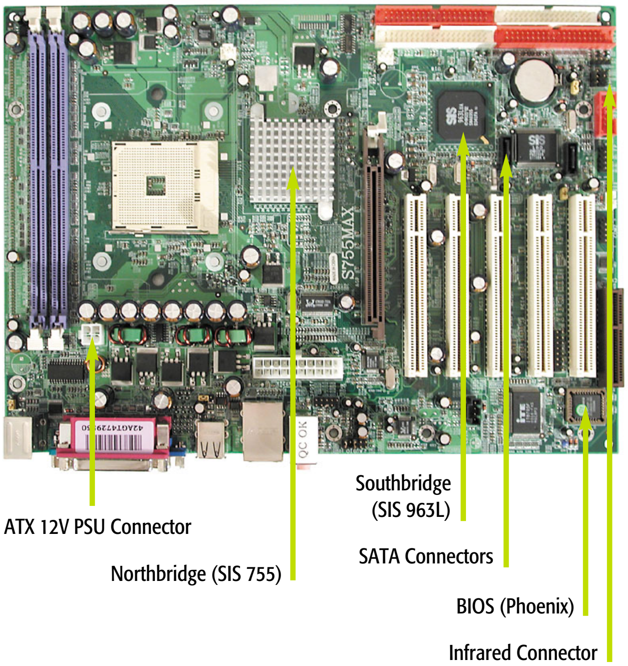
System Specs

Processor, Motherboard & Drivers	
Processor	AMD Athlon 64 3000+
Motherboard	Jetway S755MAX
BIOS Manufacturer	Phoenix
BIOS Version	V6.00PG (Jetway Version A01)
Chipset Driver	SIS 1.17.03 (755)
Common Components	
RAM	DDR SDRAM (2 x 512MB)
Video	Gainward PowerPack! Ultra/1800 XP Golden Sample (GeForce FX 5950 Ultra)
Hard Drive	80GB Western Digital WD800JD 7,200rpm SATA
Heatsink	Thermalright SLK-948U
CPU Fan	pcToys 92mm Tornado
CD-ROM	LiteOn Black 48X/24X/48X/16X DVD/CD-RW
Floppy	Samsung 1.44MB
Power Supply	Antec 430W TruePower
Case	Antec PLUS1080AMG
Temperature Monitor	MacPower Digital Doc 5

The board's two memory slots, which run horizontally, stand just under the PSU. Thankfully, Jetway didn't place any capacitors near the memory slot tabs. As a result, we installed and removed our system's memory without any trouble. The two slots don't have dual-channel functionality, but support up to 2GB of 266MHz, 333MHz, or 400MHz DDR RAM. Users who have multiple optical drives and IDE hard drives will like the board's two ATA 100 connectors and ATA 133 connector, but SATA users can install only two SATA hard drives, thanks to the two SATA connectors.

The S755MAX's SiS chipset lets the board support up to six USB 2.0 ports. The riser includes four USB ports. The internal USB connector stands near the front panel connectors. The riser also includes two PS/2 connectors, a serial connector, a parallel port, and a 10/100 LAN port that sports green and yellow activity LEDs. As with most of the boards we used, the S755MAX has a 12V connector that complements the standard ATX power connector.

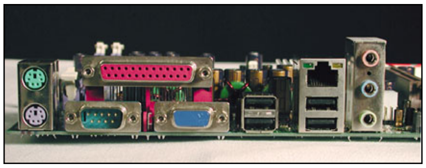
The Magic Install drivers CD lacks overclocking software but has Trend Micro's PC-cillin 2002. The software is clearly outdated, but we always like to see packages that include antivirus software. After all, you can update the software's virus definitions list online. The CD also includes ITE's Smart Guardian, which displays a variety of system specs, including CPU and system temps, and related fan speeds. It also displays current voltage settings, but doesn't let you adjust any system settings. The Magic Install program automatically detects your computer's hardware and selects the appropriate drivers.



Overclocking

We entered the Phoenix Award BIOS 6.00PG (Jetway Version A01) by pressing the DELETE key and then browsed the PC Health Status to make sure our system was ready for action. If you want to see this information whenever your computer boots, you can enable the Show PC Health In Post option. The section displays a variety of voltages, CPU and system fan speeds and temperatures, and a Shutdown Temperature feature.

Next, we entered the Advanced Chipset Features section, which offers AGP and DRAM options. The DRAM Timing Settings subsection lets overclockers fiddle with the HyperTransport and with the memory's CAS Latency, RAS Precharge Time, and RAS To CAS Delay timings. Oddly enough, Jetway placed most of the overclocking features in the Miscellaneous Control category. The section lets you adjust the DRAM clock speed (100MHz, 133MHz, 166MHz, or 200MHz), the DRAM voltage (2.5V to 2.8V), and the AGP voltage (1.5V to 1.8V). We were surprised to see that the CPU VCore feature has the widest range of the three boards we discuss in this article: 0.7V to 1.8V. Also, the BIOS allows 0.25V voltage increases, which means cautious overclockers can nudge their systems towards stability.



We were also surprised to see that the BIOS limits the CPU FSB to 233MHz. Theoretically, the ABIT KV8-MAX3 lets users push the processor to 300MHz. The Chaintech Zenith ZNF3-150 takes the cake, supporting up to 400MHz FSB's. As it turned out, Jetway's 233MHz limit easily covered our Athlon 64 3000+, but the limit might block future processors from reaching their overclocking potential.

Another noteworthy feature is the BIOS' antivirus option. If you enable Anti-Virus Protection, the BIOS monitors the hard drive and displays a warning message and emits an audible beep if an application writes to the boot sector.

We benchmarked our system before overclocking. At default settings, our test PC posted a 3Dmark03 score of 6126, a little lower than the ABIT and Chaintech boards' scores. The S755MAX also didn't make any headlines when it posted a PCMark04 score of 4018, so we weren't surprised when the system crashed at a mere 2.12GHz. As it turned out, the board was simply waiting for a little juice. The system coasted on 1.6V to 2.18GHz, 1.7V to 2.2GHz, and then collapsed at 2.25GHz, even though we bumped the voltage to 1.8V. At 2.24GHz, the S755MAX posted an overall PCMark04 score of 4481, which topped the other two boards' scores. The system also posted a respectable 6241 3Dmark03 score.

Overclock Comparison
3Dmark03

Chaintech Zenith ZNF3-150	
Stock Performance	6150
Overclocked Performance	6253
ABIT KV8-MAX3	
Stock Performance	6154
Overclocked Performance	6243
★ Jetway S755MAX	
Stock Performance	6126
Overclocked Performance	6241

Final Word

Color us surprised. We hate to admit it, but we simply didn't believe that such an inexpensive board could hold its own against such high-end competitors, let alone pull off one of the top clock speeds. Sure, it doesn't include a card reader or hard drive encryption system, but it loves to overclock. If you're an accessory fanatic, you'll probably want one of the S755MAX's competitors, but if you're building a budget overclocking system, you'll like this board. At almost half the ZNF-150's price, the S755MAX makes an outstanding buy. CPU

by Joshua Gulick

AMD ATHLON 64 3200+ & GIGABYTE GA-K8VNXP

We used the AMD Athlon 64 3200+ to test the Gigabyte GA-K8VNXP, Soyo CK8 Dragon Plus, and ASRock K8S8X. The 3200+ features the same clock speed and instruction sets as the Athlon 64 3000+ but includes AMD's ClawHammer core and double the L2 cache (1MB).

Motherboard

We haven't seen a Gigabyte board that didn't include tons of extras, software, and special features, and the GA-K8VNXP is no exception. In fact, it has several cool features that protect the board from power flows and system crashes. (Not that overclockers are ever responsible for either, of course. We wouldn't dream of stressing our precious system.) The board features VIA's K8T800 and VT8237 chipsets and a slew of peripheral chips, including Realtek's ALC658 (AC'97 codec) chip and 8110S Gigabit LAN chip, which frees up the board's PCI slots and means you won't need to spend extra money on those peripherals.

The GA-K8VNXP also includes a GigaRAID ATA 133 controller and four IDE connectors (the VT8237 southbridge handles SATA RAID 0 and RAID 1). We always like to see ATA RAID, but we were disappointed to find that our $165 motherboard sports only two SATA connectors, whereas the $141 ABIT KV8-MAX3, which has the same chipset, boasted six of them.

Gigabyte lines several capacitors close to the board's CPU bracket, but we didn't have any trouble installing our massive Thermalright SLK-948U heatsink so we're not complaining. The K8T800 northbridge, which stands just below the CPU socket, includes a copper heatsink, a lighted fan (after all, what else are window mods for?), and a fan grill. The board also includes system and power fan connectors.

The riser includes audio ports, four USB 2.0 ports, and two LAN ports, one of which is the Gigabit LAN connector. Two D-brackets complement the riser with additional USB, FireWire, and audio ports. A third D-bracket sports SATA data and power connectors. Thanks to this bracket, you can connect one or two internal hard drives to your system without actually putting the drives inside your computer. However, the bracket doesn't add SATA ports; it simply extends the board's two SATA ports to the back of your system.

The GA-K8VNXP's most important hardware includes its two BIOS chips and the DPS (Dual Power System). The two BIOS chips back up each other, which means that if one BIOS chip fails, the other will automatically kick in. As a result you can update your BIOS as often as you'd like without worrying about accidentally crippling your board. That is, until you damage the first BIOS. If a BIOS dies, the BIOS' Boot From option won't let you switch to the dead BIOS.

The DPS card plugs into a blue PCI-type slot that stands between the riser and a bunch of capacitors. Both the DPS and the mobo power circuits are three-phase circuits. Unlike the second BIOS, which doesn't affect the PC until its partner dies, the DPS provides power at the same time as the motherboard power circuit. That said, the DPS can act as a backup; if the motherboard circuit died, the DPS would continue to function. The DPS stabilizes the board's current and supports larger currents than most boards. As with the northbridge, the DPS sports a copper heatsink and a fan.

System Specs

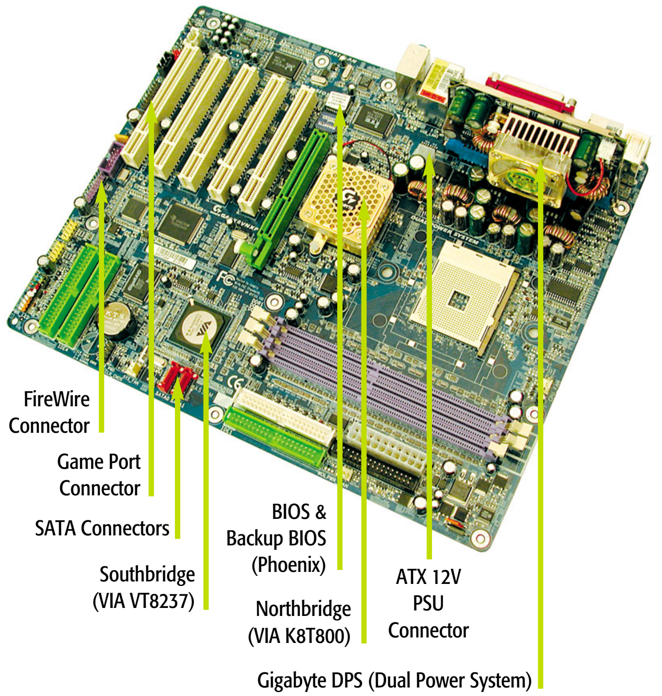
Processor, Motherboard & Drivers	
Processor	AMD Athlon 64 3200+
Motherboard	Gigabyte GA-K8VNXP
BIOS Manufacturer	Phoenix
BIOS Version	V6.00PG (Gigabyte Version F4)
Chipset Driver	VIA 4.51 (K8T800)

Common Components	
RAM	DDR SDRAM (2 x 512MB)
Video	Gainward PowerPack! Ultra/1800 XP Golden Sample (GeForce FX 5950 Ultra)
Hard Drive	80GB Western Digital WD800JD 7,200rpm SATA
Heatsink	Thermalright SLK-948U
CPU Fan	pcToys 92mm Tornado
CD-ROM	LiteOn Black 48X/24X/48X/16X DVD/CD-RW
Floppy	Samsung 1.44MB
Power Supply	Antec 430W TruePower
Case	Antec PLUS1080AMG
Temperature Monitor	MacPower Digital Doc 5

AMD Athlon 64 3200+ (ClawHammer)
Gigabyte GA-K8VNXP

	Processor Speed	FSB	Multiplier	Voltage	Processor Temp	Case Temp	3Dmark03	PCMark04	PCMark04 CPU	PCMark04 Memory	PCMark04 Graphics	PCMark04 HDD
Stock Performance	2GHz	200MHz	10	1.5	31.9	26.8	6184	4033	3772	3618	5132	4732
Overclocked Performance	2.22GHz	222MHz	10	1.55	33.3	27.3	6289	4482	4207	4043	5261	4734

Overall, we like the GA-K8VNXP's layout. Gigabyte places easy-to-read labels near each connector and throws in a few features that let overclockers easily swap components and recover from crashes. The AGP port tab, for example, has a beveled edge that let us push our Gainward video card into the AGP slot without pulling the tab. And unlike many other AGP port tabs, which are often stiff,

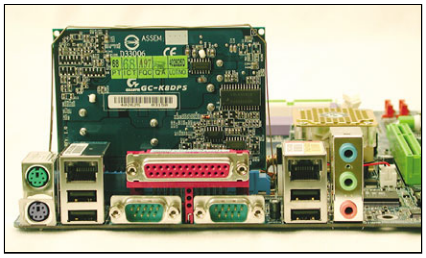


we were able to slip the AGP port's tab back easily when we removed the video card. Gigabyte also placed the CMOS jumper near the side of the board, which means an overclocker can easily reach the jumper to reset her system.

Gigabyte's driver CD includes Adobe Acrobat Reader, Symantec Norton Internet Security 2004, and Gigabyte's own @BIOS and EasyTune 4. The @BIOS is a Windows-based updater that can automatically download and install the latest BIOS update. EasyTune 4 lets you overclock your system from Windows but protects your system from potentially harmful settings. Our experience has been that Windows-based overclocking utilities simply can't compete with the board's BIOS. As a result we don't use these programs to overclock our Case Studies motherboards. That said, EasyTune 4 has some nice features. For example, it includes a Hardware Monitor section that displays a variety of temps, voltages, and fan speeds. EasyTune 4 also has two modes: Easy Mode, which only lets the user boost the CPU frequency, and Advanced Mode, which opens several other options, including component voltages.

Overclocking

The GA-K8VNXP runs the Phoenix Award BIOS V6.00PG (Gigabyte Version F4). The Frequency/Voltage Control section houses most of the overclocking features, including the DRAM (+0.1V to +0.3V), AGP (+0.1V to +0.3V), and CPU VCore (0.8V-1.7V) voltage. The section also controls the CPU clock speed. The PC Health Status section lists CPU and system fan speeds and temps and also includes Fail Warning options. If you enable Fail Warnings, the system will sound an alarm when system fans stop spinning.



We benchmarked our test system at default settings before overclocking it. At 2GHz, the system posted a 3Dmark03 score of 6168 and a PCMark04 score of 4034. We left the voltage at 1.5V and focused on the FSB. At 2.11GHz, the system crashed, so we upped the voltage to 1.55V and tried again. The board loved the extra juice and let us push the CPU to 2.17GHz, at which point it posted a 3Dmark03 score of 6260. We upped the voltage to 1.6V, pushed the processor to 2.18GHz, and then rebooted.

As soon as we restarted the PC, we smelled smoke. We shut things down and determined that the PSU was emitting the stench of burnt components. The PSU was dead, as was the motherboard. We couldn't find any physical damage, but we could smell the PSU from several feet away. We don't know which (if either) of the components caused the problem, but we were surprised that Gigabyte's Dual Power System failed to prevent it. We installed an identical PSU and bought a new GA-K8VNXP.

At default settings, the new board posted a 3Dmark03 score of 6184, slightly higher than its sibling's score. This time the system handled a VCore voltage of 1.5V at 2.22GHz but couldn't run stable at 2.23GHz. When we boosted the voltage to 1.6V and raised the clock speed to 2.24GHz, we smelled smoke. Afraid we would torch our system again, we shut down our PC and called it quits. With a 2.22GHz clock speed and 1.55V VCore, the system posted a 3Dmark03 score of 6289 and a PCMark04 score of 4482.

Luckily, the motherboard didn't die. When we returned the board to its default settings, the system booted into Windows and ran applications without any trouble or loss of performance.

Final Word

The GA-K8VNXP took top honors in our three-board round up, just barely beating out the $126 Soyo CK8 Dragon Plus, but it doesn't like voltage increases. If you're not afraid to risk the occasional motherboard blowout and you must have the fastest board around, this is a good choice. We didn't like the board's pyromaniacal tendencies, but we can't say no to raw speed.

by Joshua Gulick

Overclock Comparison 3Dmark03

★ Gigabyte GA-K8VNXP	
Stock Performance	6184
Overclocked Performance	6289
Soyo CK8 Dragon Plus	
Stock Performance	6175
Overclocked Performance	6271
ASRock K8S8X	
Stock Performance	5581
Overclocked Performance	5690

AMD ATHLON 64 3200+ & SOYO CK8 DRAGON PLUS

Call us nerds if you will. Tell us that we've succumbed to a basic marketing ploy. We simply can't help but like the idea of a dragon forming the heart of our overclocked, smoke-belching system (for some real smoking action, see our AMD Athlon 64 3200+ & Gigabyte GA-K8VNXP article on page 70). Unfortunately, while the Soyo CK8 Dragon Plus lives up to its grand title, the board's package doesn't come close. The box includes a decent software selection, but the slim box contains few extras. We found a SATA data cable, an IDE cable, a floppy cable, and a woefully slim Quick Start Guide. When we popped the board's CD into a spare computer, we quickly discovered that the CD's manual is the Quick Start Guide. The guide includes a few illustrations and some basic installation and troubleshooting instruction, and it dedicates a whopping half-page to the BIOS. Most user guides include several pages that have BIOS screen shots and explanations that let new users quickly find and learn about important features.

System Specs

Processor, Motherboard & Drivers	
Processor	AMD Athlon 64 3200+
Motherboard	SOYO CK8 Dragon Plus
BIOS Manufacturer	Phoenix
BIOS Version	V6.00PG (Soyo Version BA1)
Chipset Driver	NVIDIA v3.13 (nForce3 150)
Common Components	
RAM	DDR SDRAM (2 x 512MB)
Video	Gainward PowerPack! Ultra/1800 XP Golden Sample (GeForce FX 5950 Ultra)
Hard Drive	80GB Western Digital WD800JD 7,200rpm SATA
Heatsink	Thermalright SLK-948U
CPU Fan	pcToys 92mm Tornado
CD-ROM	LiteOn Black 48X/24X/48X/16X DVD/CD-RW
Floppy	Samsung 1.44MB
Power Supply	Antec 430W TruePower
Case	Antec PLUS1080AMG
Temperature Monitor	MacPower Digital Doc 5

AMD Athlon 64 3200+ (ClawHammer)
SOYO CK8 Dragon Plus

	Processor Speed	FSB	Multiplier	Voltage	Processor Temp	Case Temp	3Dmark03	PCMark04	PCMark04 CPU	PCMark04 Memory	PCMark04 Graphics	PCMark04 HDD
Stock Performance	2.02GHz	200MHz	10	1.5	33	28.6	6175	4063	3769	3672	5376	4494
Overclocked Performance	2.21GHz	219MHz	10	1.7	36.3	29.1	6271	4461	4168	4012	5464	4485

Motherboard

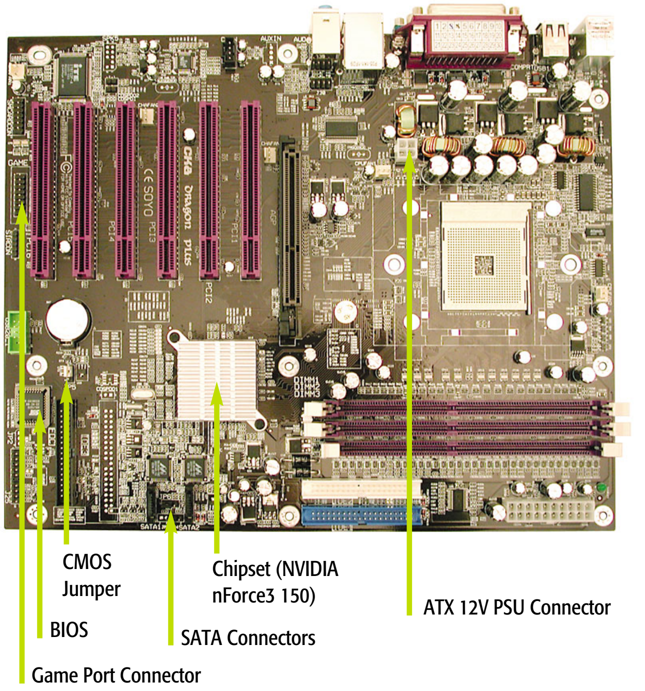
We were surprised to see that the lone SATA cable includes dust caps. We like dust caps because they protect your spare SATA cables, but thanks to Soyo's less-than-generous package, users won't have any spares to worry about. At $126, the CK8 Dragon Plus isn't the most expensive motherboard around, but even the $100 ASRock K8S8X managed to scrounge up a second SATA cable and a SATA PSU adapter.

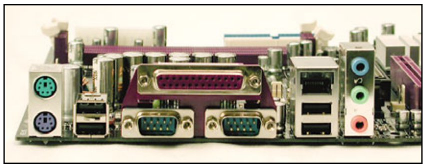
That said, we like some of the 8-In-1 Super Bonus Pack's applications. You can download Adobe Acrobat Reader free, but if you don't already use antivirus software, you can protect your system with Symantec's slightly outdated Norton AntiVirus 2003 and Norton Personal Firewall 2003. We like Ghost 2003, which lets you create a snapshot of the information on your hard drive. If you damage your operating system or any other programs while overclocking, you can use Ghost to quickly return your PC to health (assuming, of course, that you loaded Ghost and backed up your system before you began overclocking). The CD also includes Adobe Acrobat Reader and eBook Reader, Adobe ActiveShare, and trial versions of Vcom AutoSave and Imagemore.

If your system's chassis has a window, you'll love the CK8 Dragon Plus' black PCB and purple PCI slots. The board also sports three purple memory slots, which support up to 2GB of 266MHz, 333MHz, or 400MHz. Unlike AMD Athlon 64 FX-based, 940-pin motherboards, the CK8 Dragon Plus doesn't require registered memory, which means that if you are upgrading from an existing Athlon XP or Intel P4 system, you can probably transfer your memory to this motherboard. If you're not sure whether your memory is compatible with the CK8 Dragon Plus, you can scan Soyo's list of compatible memory online (www.soyousa.com).

Soyo placed most of its Sacon capacitors between the riser and the CPU socket area. Instead of using the traditional northbridge and southbridge chipsets, SOYO placed the single NVIDIA nForce3 150 chipset next to the board's six PCI slots. The chipset features a tall aluminum heatsink that sports wide fins, but the heatsink doesn't have a fan, and the board doesn't have a chipset fan header.

We like the AGP slot's simple locking system. You can unlock the slot by sliding the black plastic bar backward, which means that you can unlock the slot before you insert the card. Once the card is in place, you can easily slide the bar back into the locked position. We also liked the board's jumpers. All of the jumpers have long, easy-to-grab handles. SOYO put the icing on the cake by putting a





white jumper on the CMOS header (the other jumpers are black). As a result, you can easily find the CMOS jumper without referring to the crummy user guide.

The motherboard riser includes the standard parallel, PS/2, and serial ports, as well as four USB 2.0 ports, a 10/100 LAN port (complete with activity LEDs), and three audio ports (Line-in, Line-out, and Mic-in), thanks to a CMI 9739 (AC '97) codec. The board has a game port header, an infrared header, and a USB 2.0 header that supports two more ports, but it doesn't have a FireWire header or any FireWire ports. The CK8 Dragon Plus also has several fan headers that stand near the PCI slots. Unfortunately, one of the headers stands between the AGP slot and the first PCI slot, which means that users who have large video cards probably won't be able to access this header. However, users won't have any trouble reaching the motherboard's two SATA connectors, which stand at the front of the board, near the hard drives.

Overclocking

We didn't think much of the CK8 Dragon Plus' package, but we liked its benchmark scores right away. The board burst through the gates with a 3Dmark03 score of 6175 and an overall PCMark04 score of 4063. We entered the BIOS and navigated to the PC Health section, which lists CPU VCore, AGP, and DRAM voltages, as well as the CPU's temperature and fan speed.

The PC Health section also lists one chassis fan's speed, but it doesn't display the other chassis fans. Next, we returned to the main menu and entered Soyo's SOYO COMBO section, which houses the board-'s overclocking features. The section lets users adjust AGP (1.5V to 1.8V), DRAM (2.5V to 2.9V), and CPU VCore (0.775V to 1.7V) voltages. We like the CK8 Dragon Plus' wide voltage range, but we'd rather have higher voltage options than lower options. We suspect that we could have pushed our Athlon 64 3200+ further if the board allowed higher voltages.

Users who are new to overclocking will like the SOYO COMBO section's System Performance setting. You can change the setting from Normal to Fast or Turbo to let the motherboard choose appropriate overclocked settings. The section also has a Power On After Power-Fail feature that, if enabled, automatically reboots your system whenever the PC loses and then regains power. Interestingly enough, the SOYO COMBO section also lets you adjust the system's boot device order. Every BIOS lets you select the appropriate boot device (for example, the hard drive or floppy drive), but most BIOSes relegate the option to a different category.

Overclock Comparison 3Dmark03

Gigabyte GA-K8VNXP	
Stock Performance	6184
Overclocked Performance	6289
★ SOYO CK8 Dragon Plus	
Stock Performance	6175
Overclocked Performance	6271
ASRock K8S8X	
Stock Performance	5581
Overclocked Performance	5690

The CK8 Dragon Plus coasted on 1.5V to 2.17GHz. We had set the frequency to 215MHz, so we were surprised to see the slightly higher clock speed. As it turned out, the Phoenix Award BIOS V6.00PG (Soyo Version BA1) always displayed slightly higher clock speeds. The BIOS didn't let us change the processor's 10X multiplier.

The test PC ran at 2.22GHz, but it struggled with PCMark04, producing low scores. The system couldn't finish 3Dmark03 at 2.22GHz even when we upped the voltage to 1.7V, but the system performed well at 2.21GHz (with a 1.7V VCore), posting a 6271 in 3Dmark03, only 18 points shy of the ASRock K8S8X's top overclocked score. The CK8 also snagged a 399-point PCMark04 increase with its max score of 4461. Unfortunately, the board's 1.7V limit prevented us from pushing the processor further.

Final Word

CK8 Dragon? Yes. CK8 Dragon Plus? We don't think so. Without a doubt, the CK8 Dragon Plus is a strong overclocker, but its manual simply doesn't contain enough information and the board doesn't contain enough extras to warrant adding "Plus" to the name. That said, if you never read instructions anyway and don't need extra cables, you'll love this motherboard's looks and performance.

by Joshua Gulick

AMD ATHLON 64 3200+ & ASROCK K8S8X

System Specs

Processor, Motherboard & Drivers	
Processor	AMD Athlon 64 3200+
Motherboard	ASRock K8S8X
BIOS Manufacturer	American Megatrends
BIOS Version	ASRock Version P1.30
Chipset Driver	SIS 5.1.2600.1106 (755)

Common Components	
RAM	DDR SDRAM (2 x 512MB)
Video	Gainward PowerPack! Ultra/1800 XP Golden Sample (GeForce FX 5950 Ultra)
Hard Drive	80GB Western Digital WD800JD 7,200rpm SATA
Heatsink	Thermalright SLK-948U
CPU Fan	pcToys 92mm Tornado
CD-ROM	LiteOn Black 48X/24X/48X/ 16X DVD/CD-RW
Floppy	Samsung 1.44MB
Power Supply	Antec 430W TruePower
Case	Antec PLUS1080AMG
Temperature Monitor	MacPower Digital Doc 5

Although mainstream motherboard manufacturers such as ABIT, ASUS, and Gigabyte pack heaps of free components, overclocking utilities, and special cooling systems into their mobo packages, you don't need a high-end motherboard to overclock. If you're on a budget, you can choose from a variety of lesser-known motherboards that trade frills for low price tags. The ASRock K8S8X is one of these boards. It has few extras and programs, sports the inexpensive SIS 755 chipset, and at $100, won't break your budget.

Motherboard

As with several other mobo manufacturers, ASRock broke from the unwritten green PCB rule and instead used a bright blue PCB that will spice up your system's interior. The board meets ATX specifications, but is unusually thin, which means that users who have crowded systems can probably squeeze the board into place without much trouble. Unfortunately, the board's size meant that ASRock couldn't pile on special features, such as a FireWire header, and even had to lose some components, such as a third memory socket. That's right: the K8S8X has only two memory sockets, which support up to 2GB of 266MHz, 333MHz, and 400MHz of 184-pin DDR RAM. 2GB of RAM can easily handle most intensive tasks, including today's latest games (provided your system has an appropriate video card, of course), but we always like to see three or more sockets. Memory prices are volatile; if memory prices are high, you may be reluctant to buy two 1GB DIMMS right away. If you have extra sockets, you can buy smaller DIMMs and then add additional small DIMMs when memory prices drop. But thanks to the ASRock's two-socket layout, you'll either need to buy the 1GB DIMMs right away or remove your smaller DIMMs when you buy 1GB DIMMs later.

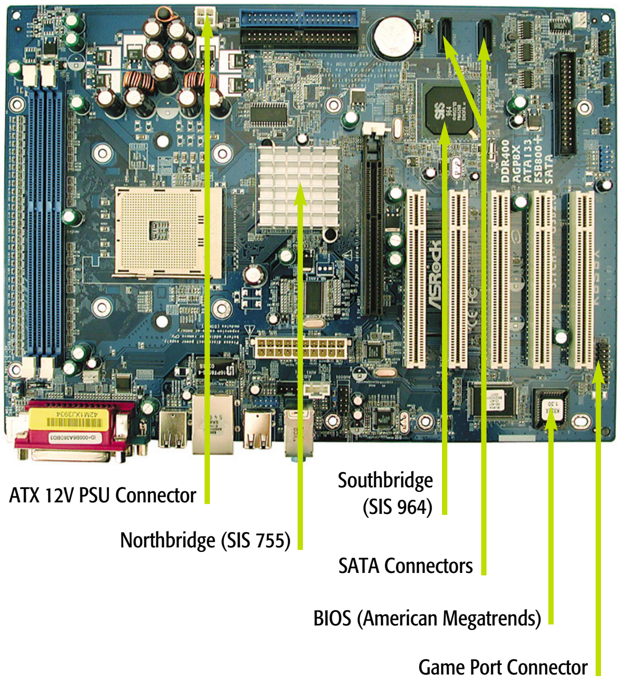
ASRock placed the 12V PSU connector at the front of the board, just above the two IDE connectors, and then put the standard power connector just behind the motherboard riser's audio ports. As a result, you'll probably have trouble keeping the PSU's large cable out of the way. You'll need to string the cable over the memory and then around the CPU to reach the connector, which means that the cable will stick out into the center of the chassis, possibly disrupting the airflow. If you have a particularly long PSU cable, you may be able to snake it around the memory. We like motherboards that sport the power connector at the top of the board, which lets us attach most of the PSU cable to the top of the case.

The CPU socket area has plenty of room, so we installed our heatsink without any trouble. The SIS 755 northbridge stands well below the CPU socket. The chipset doesn't have a fan (and the motherboard doesn't have a chipset fan header), but it probably doesn't need one; a massive aluminum heatsink sits atop the northbridge. It's one of the largest chipset heatsinks we have ever seen. The SIS 964 southbridge stands between the board's five PCI slots and two SATA connectors.

Although the board doesn't have many features, it has plenty of RAID options, including RAID 0, 1, and JBOD. The board's CD includes a special manual that explains various RAID configurations and provides installation instructions. We like the manual, but we're disappointed to see that ASRock didn't put a printed version of this manual in the package. Apparently, ASRock assumes that all users can use a spare computer to print out the manual before they build the motherboard's new system. If you are building your only system, you'll need to build the computer, print the manual, and then set up your RAID configuration. Of course, if you don't have an IDE hard drive, you'll need to find a friend who has a computer anyway; the K8S8X doesn't include a SATA driver floppy.

AMD Athlon 64 3200+ (ClawHammer)
ASRock K8S8X

	Processor Speed	FSB	Multiplier	Voltage	Processor Temp	Case Temp	3Dmark03	PCMark04	PCMark04 CPU	PCMark04 Memory	PCMark04 Graphics	PCMark04 HDD
Stock Performance	2GHz	200MHz	10	1.5	34.3	25	5581	3820	3714	3260	4342	4817
Overclocked Performance	2.28GHz	228MHz	10	1.5	35.2	25.2	5690	4343	4269	3739	4331	4745

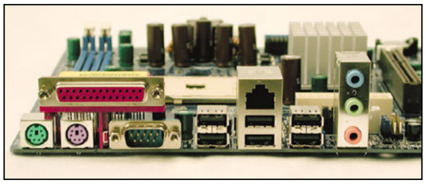


That's not to say that the K8S8X doesn't include any printed material. We found a slim user guide and a small, printed manual that includes step-by-step instructions for hot-swapping SATA hard drives. We like the user guide, which has plenty of setup information and detailed explanations of each of the board's headers. Thanks to the user guide, you can easily set up your system and then print the main user guide, which includes BIOS information, from the board's driver CD.

The motherboard riser has a 10/100 LAN port, three audio ports, and six USB 2.0 ports. The board's internal connectors include audio, infrared, USB 2.0, and game port headers. The K8S8X has a single system fan header, which stands at the front of the board, near the front panel header.

The K8S8X's slim offerings include a SATA PSU adapter, two SATA cables, a floppy cable, and an IDE cable. We were glad to see the SATA PSU adapter, but were surprised to find that the adapter includes only one hard drive connector. The board's other features include Boot Failure Guard and U-COP (Universal CPU Overheating Protection). Overclockers will like Boot Failure Guard, which lets users safely enter the BIOS after an overclocked system crashes. The board does have a CMOS header, but doesn't include the jumper. If you want to clear the CMOS via the header, you'll need to buy a jumper.

ASRock's U-COP monitors the CPU's temperature and powers off the system if it determines that the CPU is too hot. We worried that the feature would power off our system when we overclocked, but we never triggered the feature. The K8S8X also includes PC-cillin Anti-Virus and ASRock's PC DIY demo, which walks the user through motherboard installation. Of course, you'll need to use a computer to view the demo.



Overclocking

Before we entered the K8S8X's BIOS, we benchmarked the system at default settings. The system posted 5581 in 3Dmark03 and 3820 in PCMark04. We were surprised to see such low scores: the Soyo CK8 Dragon Plus scored 6175 in 3Dmark03 at default settings.

As soon as we entered the system's BIOS, we looked at the Hardware Health Event Monitoring category. The section lists the CPU temperature (which remained cool; the temp never exceeded 35 degrees Celsius, even when we overclocked), the motherboard temperature, several voltages, and CPU and chassis fan speeds. Next, we selected the Advanced tab and entered the CPU Configuration section. The section includes an AMD Cool 'N Quiet Configuration setting, but we weren't worried about heat, thanks to our massive heatsink and fan. Instead, we changed the CPU Host Frequency field from Auto to Manual and then overclocked the CPU via the Actual Frequency field.

We quickly discovered that the BIOS doesn't include features that let you adjust the CPU's voltage. As a result, we couldn't bump the voltage from its default 1.5V setting. Even so, we pushed the CPU all the way to 2.24GHz before we ran into trouble. At 2.24GHz, the system scored 4268 in PCMark04 and posted a 3Dmark03 score of 5690, only 109 points higher than its score at default settings. As it turned out, the system couldn't break this 3Dmark03 score. The PC crashed when we pushed it to 2.26GHz, so we lowered the HyperTransport speed from 800MHz to 600MHz and then overclocked again. This time, the system reached 2.3GHz, but posted poor benchmark scores, so we backed it down to 2.28GHz. At 2.28GHz, our PC scored 5690 in 3Dmark03 again, but posted a slightly better 4343 PCMark04 score.

Overclock Comparison 3Dmark03

Gigabyte GA-K8VNXP	
Stock Performance	6184
Overclocked Performance	6289
Soyo CK8 Dragon Plus	
Stock Performance	6175
Overclocked Performance	6271
★ ASRock K8S8X	
Stock Performance	5581
Overclocked Performance	5690

Final Word

Although the K8S8X achieved the highest clock speed, it posted the lowest benchmark scores of our trio. Overclockers probably won't enjoy this board's lack of overclocking features and components, but budget-builders who need an inexpensive board shouldn't ignore it.

by Joshua Gulick

AMD Athlon 64 3400+ & Albatron K8X800 ProII

System Specs

Processor, Motherboard & Drivers	
Processor	AMD Athlon 64 3400+
Motherboard	Albatron K8X800 ProII
BIOS Manufacturer	Phoenix
BIOS Version	V6.00PG (Albatron Version R1.08)
Chipset Driver	VIA 4.51 (K8T800)
Common Components	
RAM	DDR SDRAM (2 x 512MB)
Video	Gainward PowerPack! Ultra/1800 XP Golden Sample (GeForce FX 5950 Ultra)
Hard Drive	80GB Western Digital WD800JD 7,200rpm SATA
Heatsink	Thermalright SLK-948U
CPU Fan	pcToys 92mm Tornado
CD-ROM	LiteOn Black 48X/24X/48X/16X DVD/CD-RW
Floppy	Samsung 1.44MB
Power Supply	Antec 430W TruePower
Case	Antec PLUS1080AMG
Temperature Monitor	MacPower Digital Doc 5

AMD's Athlon 64 3400+ has the 3200+'s ClawHammer core, 128KB of L1 cache (a 64KB instruction cache and a 64KB data cache) and 1MB of L2 cache, but it boasts a 2.2GHz clock speed. Unfortunately, the processor's integrated memory controller still supports only one channel, which means that Athlon 64 users can't take advantage of the dual-memory-channel technology that many Athlon XP users enjoy (via motherboards that have appropriate chipsets). At $406 the 3400+ isn't a budget CPU, but it's much less expensive than the Athlon FX-51, which also has a 2.2GHz clock speed. All Athlon 64s have integrated antivirus technology, but they won't be able to fully use it until Microsoft releases Windows XP Service Pack 2.

Motherboard

We stress hardware to its breaking point when we put together *PC Modder* issues, so we occasionally see smoking components keel over. As it happens, the first K8X800 died (from fear, we suspect, and we don't blame the poor thing) before we put it in our test system, so we ordered a replacement that ran right away. The K8X800 ProII sports VIA's K8T800 northbridge and VT8237 southbridge, which provides support for the board's two SATA hard drive connectors. Albatron also threw in a VIA VT6307 FireWire chip and a VIA VT1720 Envy 24PT audio controller, but we chose a 3Com 3C940 Gigabit LAN controller.

The K8X800 ProII has a solid package. The box contains several standard components, including two IDE cables, a floppy cable, a SATA cable, and a single SATA PSU adapter. We found several D-brackets, including a bracket that houses SPDIF In and SPDD Out, mic, and earphone ports. Thanks to the Envy 24PT controller, the board supports up to eight-channel audio. Albatron also threw in three other D-brackets that house USB 2.0, FireWire, and game ports.

New users and old pros will like the K8X800's printed material, which includes a user guide and a detailed installation poster that labels all of the motherboard's important components and even offers some basic BIOS information. The user guide includes detailed BIOS instructions, screenshots, and illustrations. The package also includes two free applications: the aging Trend Micro PC-cillin 2002 and InterVideo WinCinema, which features InterVideo WinDVD 4 and InterVideo WinRip 2.

Albatron packed tons of features into the board itself. The first unusual item we noticed is the four-switch device that stands in the bottom-right corner of the board. The device lets users configure the board's Voice Genie, which emits audible error messages, and the dual BIOS system. Thanks to the two 2MB BIOS chips, you can flash your BIOS without worrying that you'll accidentally damage it. If you (or a virus) kill the first BIOS, you can switch to the backup BIOS by flipping the first three switches (unlike the Gigabyte GA-K8VNXP, which automatically switches to the healthy BIOS). The Voice Genie uses English by default, but if you want it to speak Chinese, German, or Japanese, you can use the switch device to select the appropriate language.

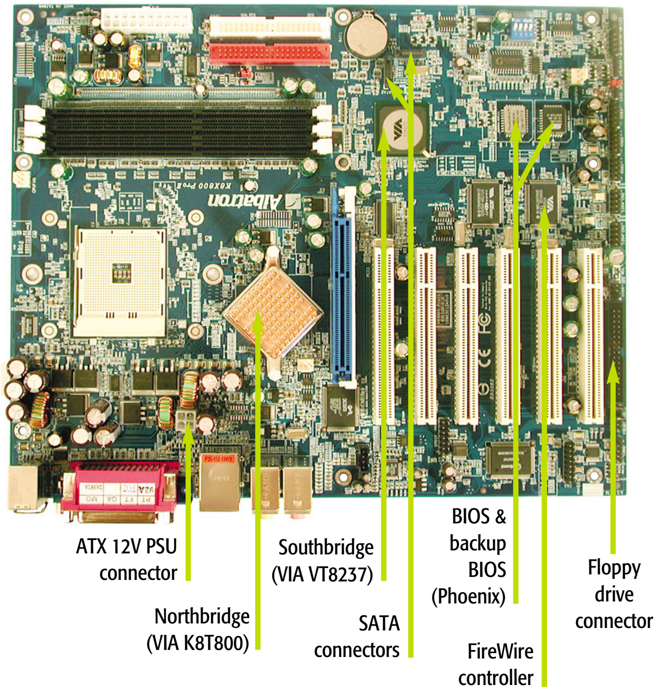
We were also surprised to find that the floppy drive connector stands at the bottom of the mobo, just below the board's six PCI slots. If you don't plug a PCI card into the bottom slot, you can easily route the floppy cable to the floppy drive, but if the slot does have a device, you may have trouble wrapping the included flat floppy cable around the PCI card.

Although the northbridge, which has a large heatsink, stands just below the CPU bracket, we didn't have any trouble installing our huge CPU heatsink and fan combo. Three RAM sockets stand to the right of the CPU. The sockets support up to 3GB of 200MHz/266MHz, 333MHz, and 400MHz DDR RAM. The board has

AMD Athlon 64 3400+ (ClawHammer) Albatron K8X800 ProII

	Processor Speed	FSB	Multiplier	Voltage	Processor Temp	Case Temp	3Dmark03	PCMark04	PCMark04 CPU	PCMark04 Memory	PCMark04 Graphics	PCMark04 HDD
Stock Performance	2.21GHz	200MHz	11	1.5	33.6	26.1	6204	4251	4111	3290	5027	4755
Overclocked Performance	2.46GHz	224MHz	11	1.7	38.3	26.3	6303	4736	4524	3663	5174	4736

a variety of internal headers, including three internal USB 2.0 headers, an infrared header, and a front panel audio header. Unfortunately, the headers stand at the bottom of the board, which means that if you put the D-brackets in the uppermost PCI slot bays, you'll need to route them between your PCI cards. That said, all of the D-bracket cords are more than long enough to reach their respective headers.



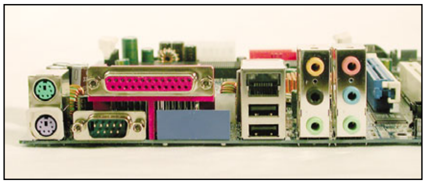
Many motherboard risers feature two serial ports, which stand next to a larger parallel port. The K8X800 ProII, however, has only one serial port; a piece of blue plastic covers the other serial port area and wards against dust. Instead of putting the serial port on the board, Albatron added an internal serial port header and put the remaining serial port on the D-bracket that also houses the game port. As a result, users who have a front-panel serial port can connect the port's cable to the motherboard.

The riser also has two USB 2.0 ports and six audio ports, including Surround Speaker, Surround Back Speaker, and Subwoofer. The audio ports don't include labels, but they are color-coded, and the installation poster describes each port.

Overclocking

The K8X800 runs Phoenix Award BIOS V6.00PG (Albatron Version R1.08). It closely resembles the other BIOSes in our three-board round-up, but it includes an overclocking feature that the others lack: the Watch Dog Timer. If your system hangs, the Watch Dog Timer automatically senses the problem, resets your BIOS to its default setting, and then reboots your PC. The board has a CMOS jumper, but thanks to the Watch Dog Timer, you'll probably never see it.

We entered the Advanced Chipset Features category and found that this section houses adjustable memory timings (including tRCD, tRAS, tRP, and CAS Latency) and some AGP settings. We



focused on the processor, so we returned to the main menu and then glanced at the Hardware Monitor. This section displayed CPU and system temperatures and fan speeds, as well as voltages but didn't let us adjust voltages. However, the Hardware Monitor does have two adjustable fields: Case Open Warning and CPU Warning Temperature. If you want the BIOS to alert you when your CPU's temperature rises beyond a specific trigger point, you can choose a temperature between 50 degrees Celsius and 70 degrees Celsius.

Next, we selected the Advanced tab and then entered the Frequency/Voltage Control section, which lets users adjust the CPU frequency (200MHz to 300MHz), the AGP/PCI frequency, and the CPU VCore (0.8V to 1.9V), RAM (2.6V to 2.9V), and AGP (1.5V to 1.8V).

The K8X800 performed well at default settings, posting 6204 in 3Dmark03 (654 points higher than the AOpen AK89 Max's score at default settings), so we upped the FSB from 200MHz to 210MHz (2.31GHz clock speed, thanks to the Athlon 64 3400+'s 11X multiplier). The system handled the new frequency without any trouble, posting a 31-point 3Dmark03 increase. Our system remained stable until it reached 2.35GHz, at which point it froze during 3Dmark03. We raised the VCore voltage from 1.5V to 1.55V and tried again. This time the system ran 3Dmark03 without trouble, but the system froze again when we boosted the clock speed to 1.6V.

We finally maxed out the system at 224MHz (2.46GHz clock speed) with a 1.7V VCore. The system posted a 3Dmark03 score of 6303, almost 100 points higher than its original score.

Overclock Comparison 3Dmark03

★ Albatron K8X800 ProII	
Stock Performance	6204
Overclocked Performance	6303
AOpen AK89 Max	
Stock Performance	5550
Overclocked Performance	6293
ECS 755-A2	
Stock Performance	5607
Overclocked Performance	5619

Final Word

The Albatron took top honors in our three-board lineup, thanks to its 2.46GHz clock speed and impressive 3DMark scores, but it didn't beat the AK89 Max by much. Both boards performed well and have excellent features. If we had to choose between the two, we'd probably lean toward the K8X800, if only because it has a three-year warranty (the first year includes parts and labor; the second and third years include only labor). The AK89 Max includes a one-year warranty. CPU

by Joshua Gulick

AMD Athlon 64 3400+ & AOpen AK89 Max

AOpen is one of the few motherboard manufacturers that still tosses a decent installation poster into its mobo packages. The AK89 Max's poster includes plenty of pictures, basic setup instructions, and a few tips that even experienced overclockers can appreciate, such as the location of the CMOS jumper. New users will like the poster's front panel connector instructions. We also like the user guide, which has tons of illustrations, component and feature descriptions, and tutorials that walk you through the package's software. Unfortunately, the user guide doesn't offer much information about the board's BIOS.

Motherboard

The AK89 Max includes a strong component package. The box contains several D-brackets that house audio ports, two FireWire ports, two USB 2.0 ports, and a game port. We also found two IDE cables, a floppy cable, a single SATA cable (sigh) and a SATA PSU adapter. We were surprised to find that the adapter includes only one hard drive connector; most PSU adapters have two hard drive connectors. AOpen also tossed a SATA driver floppy into the package, which meant we didn't have to use a separate computer to create a driver floppy. This is a small feature, but users who don't have a spare computer will trade extra SATA cables for that driver floppy any day.

The board includes two third-party applications: Adobe Acrobat Reader and Symantec Norton AntiVirus 2003. AntiVirus 2003 is outdated, but it's free software and it still downloads virus definition lists (the software includes a 12-month virus definition list subscription). AOpen also included several of its own utilities and entertainment applications. The aptly named WinBIOS lets you access the BIOS from Windows, which means you can browse and adjust the settings without first rebooting. We like the AOConfig Utility, which displays information about several components, including your BIOS, memory, motherboard, and processor. If you use the board's SATA RAID capability, you'll probably want to install the board's SATARAID Utility, which lets you manage your RAID configuration from Windows.

AOpen's SilentTek won't help overclockers, but users who hate noise pollution will love this program. The software monitors your CPU and system temperature (via the motherboard's sensors) and slows fan speeds to provide a steady, but quiet, airflow. You can adjust the software's default settings and turn on the CD-ROM Rotation Speed Control, which quiets your optical drive (at the expense of speed, of course). The AK89 Max also has a program that lets you use your computer to play CDs. Unfortunately, Open JukeBox Player prevents your system from booting windows (until you exit the program). The software provides its own mouse-friendly interface. We're certain that someone, somewhere just loves this feature.

System Specs

Processor, Motherboard & Drivers	
Processor	AMD Athlon 64 3400+
Motherboard	AOpen AK89 Max
BIOS Manufacturer	Phoenix
BIOS Version	V6.00PG (AOpen Version R1.05)
Chipset Driver	NVIDIA v3.13 (nForce3 150)

Common Components	
RAM	DDR SDRAM (2 x 512MB)
Video	Gainward PowerPack! Ultra/1800 XP Golden Sample (GeForce FX 5950 Ultra)
Hard Drive	80GB Western Digital WD800JD 7,200rpm SATA
Heatsink	Thermalright SLK-948U
CPU Fan	pcToys 92mm Tornado
CD-ROM	LiteOn Black 48X/24X/48X/16X DVD/CD-RW
Floppy	Samsung 1.44MB
Power Supply	Antec 430W TruePower
Case	Antec PLUS1080AMG
Temperature Monitor	MacPower Digital Doc 5

AMD Athlon 64 3400+ (ClawHammer)
AOpen AK89 Max

	Processor Speed	FSB	Multiplier	Voltage	Processor Temp	Case Temp	3Dmark03	PCMark04	PCMark04 CPU	PCMark04 Memory	PCMark04 Graphics	PCMark04 HDD
Stock Performance	2.2GHz	200MHz	11	1.5V	32.6	29.3	5550	4355	4152	3797	5155	4643
Overclocked Performance	2.37GHz	215MHz	11	1.55V	33.1	29.3	6293	4695	4428	4084	5497	4657

As much as we like the AK89 Max's extra components and applications, we love the board itself. It has a ton of great features, including FireWire headers and two BIOS chips (AOpen calls the dual-chip feature DieHard BIOS II). As with the Gigabyte GA-K8VNXP, the second BIOS acts as a backup. DieHard BIOS II replaces the original DieHard BIOS, which included a read-only rescue BIOS. The new version now includes a read/write rescue BIOS, which means you can write data to your BIOS. For example, you can download Open JukeBox Player skins.

The CMOS header stands directly above the BIOS chips, sporting a red jumper. Many motherboards have labels that identify the CMOS jumper, but AOpen took it a step farther by adding a label that indicates Normal and Clear CMOS positions. Seasoned overclockers won't have much trouble clearing

CMOS, but new overclockers will probably appreciate the tip.

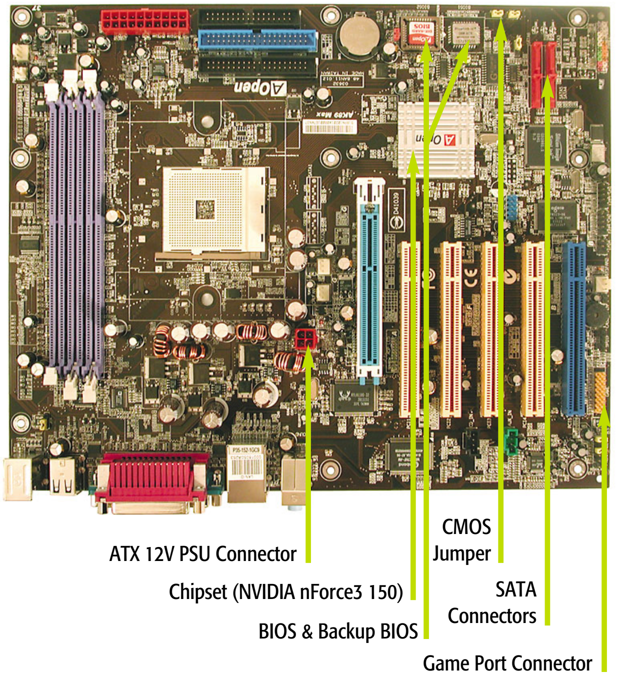
The AK89 Max sports NVIDIA's nForce3 150 chipset, which doesn't require a southbridge. AOpen placed an aluminum heatsink on the chipset, which stands just behind the PCI slots. We like the nForce 3 150's location simply because you can install a taller heatsink. In contrast, ASUS placed the nForce3 150 directly behind the SK8N's AGP slot, which meant that users couldn't easily replace the chipset's heatsink.

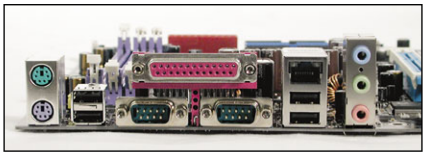
The board also includes four SATA connectors and supports RAID 0, 1, and 0+1, thanks to a Silicon Image SATALink chip. The three memory slots support up to 3GB of DDR400 RAM. We were surprised to find that one of the AK89 Max's five PCI slots has its own 3.3V power circuit. With the 3.3V circuit, the PCI slot can handle power-hungry PCI cards, such as RAID cards, and won't be affected by the other four slots.

The motherboard riser includes the standard serial, parallel, and PS/2 slots, as well as four USB 2.0 slots and a Gigabit LAN port. Thanks to the ALC655 codec, the riser's audio ports support 5.1-channel sound. One of the board's D-brackets houses additional audio ports, including SPDIF Out and SPDIF In ports.

Overclocking

If you're new to overclocking, you may want to try the AK89 Max's EzClock overclocking software. Experienced overclockers will probably want to dive right into the BIOS as it generally produces the best overclocking results, but new overclockers should think of a Windows-based overclocking tool as a training ground: Users can access all of the relevant settings from a single interface instead of flipping through BIOS sections. You can adjust processor settings and some voltages, and thanks to a drop-down window, monitor the CPU temperature in Celsius and Fahrenheit. Once you change the board's configuration, you can apply the changes immediately, without rebooting the system.





We wanted to push our system to its limit, so we rebooted our PC and then entered the BIOS during POST (power on self test). The first thing we noticed was that the BIOS let us change the CPU's multiplier. Most of the motherboards we tested don't unlock the multiplier, but AK89 Max offered a wide range of multipliers, from 4X to 25X. The BIOS also let us adjust the CPU's frequency (200MHz to 250MHz) and CPU VCore (0.8V to 1.55V), AGP (1.5V to 1.6V), and DRAM, (2.5V to 2.85V) voltages. We were surprised to find that the VCore field prevents users from raising the voltage beyond 1.55V; many motherboards let users raise the voltage as high as 1.8V. As a result, we didn't expect the AK89 Max to overclock well.

When we benchmarked our AK89 Max system at default settings (2.2GHz, 1.5V VCore), it posted a 3Dmark03 score of 5550 and a PCMark04 score of 4355. Although we expected the board's low voltage limit to curb our overclocking efforts, we didn't expect to see such low scores right off the bat. As it turned out, the AK89 Max simply needed to be unleashed. When we bumped the CPU clock speed to 2.31GHz, the system came to life, posting 6280 in 3Dmark03: a 730-point increase. The system crashed when we raised the clock speed to 2.37GHz, so we upped the VCore voltage to its 1.55V limit. Thanks to the extra juice, the AK89 Max posted its highest scores: 6293 in 3Dmark03 and 4696 in PCMark04.

Unfortunately, we couldn't top those scores, even when we adjusted the CPU's multiplier. The system booted into Windows at 2.97GHz (212MHz with a 14X multiplier), but it posted a 3Dmark03 score of 6279, 14 points below its top score. We probably could have pushed the CPU further if the board had better voltage capabilities.

Overclock Comparison 3Dmark03

Albatron K8X800 ProII	
Stock Performance	6204
Overclocked Performance	6303
★ AOpen AK89 Max	
Stock Performance	5550
Overclocked Performance	6293
ECS 755-A2	
Stock Performance	5607
Overclocked Performance	5619

Final Word

Despite the AK89 Max's mediocre scores at default settings, the board proved to be a strong overclocker. In fact, its 3Dmark03 score almost tied the Albatron K8X800's best score. If you're looking for a solid, feature-laden board, you've found it. CPU

by Joshua Gulick

AMD ATHLON 64 3400+ & ECS 755-A2

If you're planning to build a cheap PC, take a look at ECS (EliteGroup Computer Systems). The motherboard manufacturer produces a variety of inexpensive motherboards that power many budget systems. We chose one of the motherboard maker's top AMD Athlon 64-based boards, the 755-A2, to see if a budget board can compete with the big dogs.

Motherboard

The 755-A2's box states that the board is capable of overclocking, so we matched it with our Athlon 64 3400+ and took it for a spin. The board sports the SIS 755 northbridge and SIS 964 southbridge, which generally accompany inexpensive motherboards.

At $87, the 755-A2 has the dubious honor of being the cheapest AMD motherboard we overclocked. The package includes only the bare necessities: an IDE cable, a floppy cable, and a single SATA cable. We always like to see important components, such as SATA PSU adapters and extra SATA adapters, but we're willing to give up a few components for such an inexpensive board. If your PSU doesn't have SATA connectors and you are planning to buy a motherboard that doesn't have a SATA PSU adapter, buy a retail hard drive instead of an OEM version. Many computer retailers offer OEM components that lack extra features but also sell retail versions that include standard components, such as cables and free software.

System Specs

Processor, Motherboard & Drivers	
Processor	AMD Athlon 64 3400+
Motherboard	ECS 755-A2
BIOS Manufacturer	Phoenix
BIOS Version	V6.00PG (ECS Version 1.0)
Chipset Driver	SIS 5.1.2600.0 (755)
Common Components	
RAM	DDR SDRAM (2 x 512MB)
Video	Gainward PowerPack! Ultra/1800 XP Golden Sample (GeForce FX 5950 Ultra)
Hard Drive	80GB Western Digital WD800JD 7,200rpm SATA
Heatsink	Thermalright SLK-948U
CPU Fan	pcToys 92mm Tornado
CD-ROM	LiteOn Black 48X/24X/48X/16X DVD/CD-RW
Floppy	Samsung 1.44MB
Power Supply	Antec 430W TruePower
Case	Antec PLUS1080AMG
Temperature Monitor	MacPower Digital Doc 5

AMD Athlon 64 3400+ (ClawHammer)
ECS 755-A2

	Processor Speed	FSB	Multiplier	Voltage	Processor Temp	Case Temp	3Dmark03	PCMark04	PCMark04 CPU	PCMark04 Memory	PCMark04 Graphics	PCMark04 HDD
Stock Performance	2.2GHz	200MHz	11	1.5	33	27.7	5607	4206	4161	3797	4296	4378
Overclocked Performance	2.24GHz	204MHz	11	1.5	33.4	28.1	5619	4299	4254	3887	4341	3732

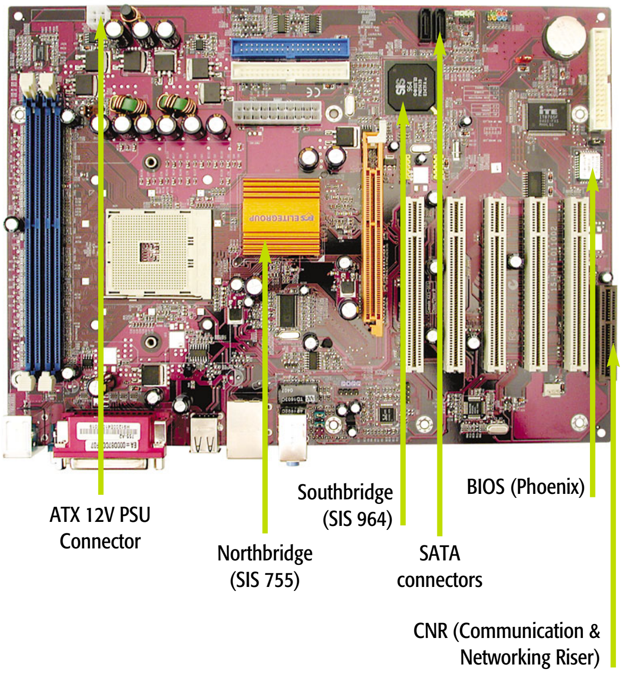
We like the 755-A2's layout. If you plan to upgrade your computer or overclock often, look for a motherboard that has an easy-to-access layout. A solid motherboard layout means you can reach important items (such as the CMOS jumper) quickly, and lets you connect various cables and cards easily without disrupting your system's airflow. ECS used a grape-purple PCB that will brighten your system's insides and then added a bright orange AGP slot and matching chipset heatsink. ECS didn't bunch the capacitors together and put both of the SATA connectors near the hard drives (assuming your hard drives are near). The board integrates support for RAID 0 and RAID 1, which means users who have two drives can create striped or mirrored arrays.

The CMOS header is near the front of the board and easy to find, thanks to the red jumper. Most importantly, ECS put detailed header labels on the motherboard that indicate CMOS Normal and Clear positions. ECS also added a small diagram that indicates the appropriate front panel pins. If you lose your manual, you'll love this diagram.

The memory slots stand horizontal, above the CPU socket, instead of standing to the left or right of the CPU. Generally, horizontal memory sockets mean that the user must string the PSU cables over the memory, but in this case, ECS placed both power cable connectors and several capacitors on the right hand side of the board. As a result we easily snaked the PSU cable around the memory and capacitors to the connectors. Unfortunately, the memory bank includes only two slots, which means that users can't easily upgrade without removing existing DIMMS. The slots support up to 2GB of DDR400 RAM.

We were surprised to find that the board lacks a game port header or even a serial port header (motherboards that have only one serial port generally include an internal serial port header that lets users add their own serial port). The board does include a CNR (communications and networking riser), but we'd take a game port header over the less-popular CNR any day.

The motherboard riser includes a serial port, a parallel port, two PS/2 ports, four USB 2.0 ports and a 10/100 LAN Port, thanks to a Realtek RTL820BL chip. Realtek also provides the riser's six-channel audio via a ALC655 (AC'97) codec. The board also includes two internal USB 2.0 headers that let you connect additional USB 2.0 ports, such as your chassis' front panel USB ports. If your chassis doesn't have USB ports, take a look at your system's other components: temperature monitors that plug into an optical drive bay and card readers often have USB ports that connect to your motherboard's internal headers. We were surprised to see that ECS placed the USB headers just behind the top two PCI slots instead of at the bottom of the board, but our front panel connectors easily reached them, so we're not complaining.

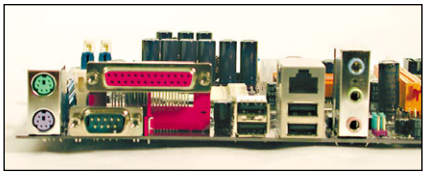


Unfortunately, the 755-A2's software package is as slim as its component package. The driver CD includes a woefully outdated Trend Micro PC-cillin 2002 and Award WinFlash, which is, not surprisingly, a Windows-based BIOS flashing utility.

Overclocking

We benchmarked the system at default settings (2.2GHz, 1.5V VCore) before we began overclocking. Our 755-A2 and Athlon 64 3400+ combo ran both benchmarks without a hitch, posting 5607 in 3Dmark03 and 4206 in PCMark04. Both of these scores were well below the Albatron K8X800 ProII's scores, but the $87 755-A2's 3Dmark03 score bested the $156 AOpen AK89 Max's opening 5550 score by 57 points.

Next, we entered the board's Phoenix Award BIOS V6.00PG (ECS Version 1.0). The PC Health Status section displays the CPU and system temps and fan speeds and lets users specify an emergency shutdown temperature. We were surprised to see that the section displays only the CPU's voltage; many BIOS' also display AGP and DRAM voltages. The Advanced Chipset Setup controls several AGP settings and devotes a subsection to DRAM settings.



The Power Management Setup section includes a couple of useful nonoverclocking tools. If you want your computer to power on automatically whenever it loses and then regains power, you can enable the section's Power On After Power Fail option. You can also configure your system to automatically power on at a specific time. If you power off your computer before you go to work, for example, you can instruct the PC to power on just before you arrive home.

The Frequency/Voltage Control section lets you adjust the CPU clock speed, but it doesn't let you adjust the voltage. As a result we couldn't feed more power to the VCore than the board's default 1.5V. Given that the board didn't include adjustable voltage controls, we suspected that ECS wasn't targeting the board at overclockers. But we tried anyway. We raised the Athlon 64 3400+'s clock speed to 2.22GHz and then booted into Windows without a hitch. The system posted a 3Dmark03 score of 5614, only seven points higher than its original score, but then, we hadn't raised the frequency much. We raised the clock speed to 2.23GHz and ran the benchmarks again. This time the system posted a 3Dmark score of 5609.

The system finally posted its best 3Dmark03 score (5619, a mere 12-point increase) at 2.24GHz. Our test PC booted into Windows at 2.31GHz but was so unstable it couldn't run any benches.

Overclock Comparison 3Dmark03

Albatron K8X800 ProII	
Stock Performance	6204
Overclocked Performance	6303
AOpen AK89 Max	
Stock Performance	5550
Overclocked Performance	6293
★ ECS 755-A2	
Stock Performance	5607
Overclocked Performance	5619

Final Word

If you're looking for a flashy, feature-laden, overclocking wonder, skip the ECS 755-A2. The board lacks important features, such as FireWire, and simply can't push your Athlon 64 processor as far as it can go. Overclockers should avoid any board that doesn't let them increase the voltage; if you can't feed extra juice to the processor, you can't stabilize the CPU when it tackles higher frequencies. That said, budget users who don't plan to overclock and don't want extra features will love this board's layout and ultra-cheap price tag. If you are building a system for a friend who wants 64-bit goodness but doesn't want to overclock, you can save cash for other components by installing the 755-A2. CPU

by Joshua Gulick

AMD ATHLON 64 FX-51 & ASUS SK8V

The Athlon 64 FX-51 shares several features with its Athlon 64 cousin, including the ClawHammer core, 128KB L1 cache, and 1MB L2 cache, but it has 940 pins to the Athlon 64's 754 and requires registered memory. As a result, if you're upgrading to a 940-pin, FX-based system, you'll need to buy a new motherboard and new RAM. Luckily, AMD recently released several 939-pin Athlon 64 FX CPUs, including a 939-pin FX-53. (We couldn't get hold of these before we went to print, so expect to see them in the next issue.) What's the big deal? The 939-pin processors don't require registered memory. AMD's roadmap doesn't include any more 940 pins, so if you plan to upgrade to an FX CPU, we suggest looking at the new processors. If you already have a 940-pin processor or simply want to see how the FX CPUs stack up, read on.

Motherboard

ASUS released the SK8V several months after it launched its first AMD Athlon 64 FX-51-based motherboard, the SK8N. The SK8N sported NVIDIA's nForce3 pro 150 chipset, which combined the northbridge and southbridge functions into a single chip. The SK8V, on the other hand, boasts a VIA chipset that includes the K8T800 northbridge and VT8237 southbridge. The board also includes a VIA VT 6307 FireWire controller, a Promise R20378 RAID controller, and an ADI AD1985 6-channel codec.

Although ASUS' low-end boards often include few extras, high-end boards, such as the SK8V, boast large packages. Our SK8V box included two SATA cables, complete with dust caps, three IDE cables, and a single SATA PSU adapter that sports two hard drive adapters. Some new power supplies include SATA power connectors, but most older models and many new models have only the older, bulky connectors, so we always like to see motherboards that save us the extra trip to the computer store.

As usual, ASUS tossed a detailed user guide and an easy-to-read motherboard layout sticker into the box. If you regularly adjust jumper settings or disconnect and reconnect the chassis' front panel connectors, you may want to place the sticker on your chassis' side panel. We were surprised to see that the sticker even lists the CMOS battery's model number. If you hang onto the board long enough to wear out the battery (or if it goes bad), you'll need this information.

The motherboard package also includes three D-brackets that attach to your chassis' empty PCI slot bays. We like the audio bracket, which has two SPDIF Out ports, and the USB bracket, which boasts four USB 2.0 ports, but we were surprised to see that the third bracket has only a FireWire port. Sure, many cases have at least one front panel FireWire port that can use the board's remaining FireWire header, but if your case doesn't have a FireWire port, one of the two headers is useless.

System Specs

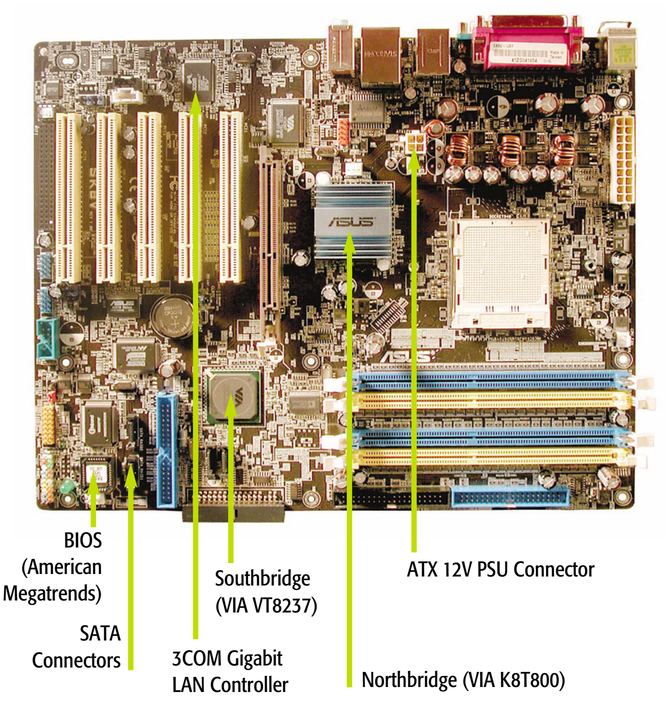
Processor, Motherboard & Drivers	
Processor	AMD Athlon 64 FX-51
Motherboard	ASUS SK8V
BIOS Manufacturer	American Megatrends
BIOS Version	AMI Bios 2003 ASUS Version 1002
Chipset Driver	VIA 4.51 (K8T800)

Common Components	
RAM	Corsair PC2700 registered DDR SDRAM (2 x 1GB)
Video	Gainward PowerPack! Ultra/1800 XP Golden Sample (GeForce FX 5950 Ultra)
Hard Drive	80GB Western Digital WD800JD 7,200rpm SATA
Heatsink	Thermalright SLK-948U
CPU Fan	pcToys 92mm Tornado
CD-ROM	LiteOn Black 48X/24X/48X/16X DVD/CD-RW
Floppy	Samsung 1.44MB
Power Supply	Antec 430W TruePower
Case	Antec PLUS1080AMG
Temperature Monitor	MacPower Digital Doc 5

ASUS also added InterVideo's WinDVD Suite, which includes WinDVD, Win DVD Creator, and WinRIP, Trend-Micro PC-cillin 2002, and plenty of its own utilities. We like the VIA Tech RAID BIOS utility, which lets you configure your RAID array (the board supports RAID 0, 1, and 0+1). You can enter Tech RAID BIOS by pressing the tab during your system's POST (power on self test). The software package also includes Winbond Voice Editor, which lets you change the POST Reporter's default messages by recording your own. Thanks to a Winbond speech controller, POST Reporter (when enabled) emits audible messages, including system errors. That sure beats hunting down the meaning of beep- or numeral-based error codes.

AMD Athlon 64 FX-51 (ClawHammer)
ASUS SK8V

	Processor Speed	FSB	Multiplier	Voltage	Processor Temp	Case Temp	3Dmark03	PCMark04	PCMark04 CPU	PCMark04 Memory	PCMark04 Graphics	PCMark04 HDD
Stock Performance	2.2GHz	200MHz	11	1.5	33.4	27.9	6250	4461	4112	4668	5221	4751
Overclocked Performance	2.45GHz	223MHz	11	1.7	39.3	29	6359	4919	4589	5204	5399	4749

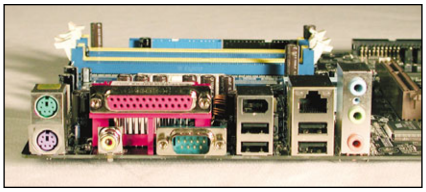


ASUS lined two of the SK8V's three IDE ports against the front side of the board. The other IDE connector sits next to the floppy connector, which is also near the side of the board. We were surprised to see that the floppy drive faces toward the front of the computer instead of facing toward the side panel, as most floppy and IDE connectors generally do. Thanks to the floppy connector's weird position, you won't have any trouble accessing the two nearby SATA ports, but we think users who have cramped cases may have trouble installing the floppy drive connector. We easily connected the cable in our case, but then, the Antec PLUS1080-AMG is very roomy.

A small, long ASUS WiFi@Home connector sits just below the motherboard's five PCI slots. If you want to add wireless connectivity to your system without adding a PCI or USB device, you can plug ASUS' optional Wi-Fi card into the connector. You can buy the 802.11b card, which includes an external antenna, for about $25 from computer retailers. We like the idea, but we wish ASUS offered an 802.11g card; a slow network adapter doesn't belong on a fast board.

Thanks to the SK8V's dual-channel architecture support, you can boost your system's performance by adding pairs of identical DIMMS to memory slots. The motherboard's four slots support up to 8GB of PC3200 registered DDR RAM.

The I/O riser includes a SPDIF-Out port, three other audio ports, four USB 2.0 ports, and a FireWire port. If you take your computer to LAN parties, you'll like the riser's Gigabit LAN port. Thanks to the 3COM 3C940 Gigabit LAN controller's VCT (Virtual Cable Tester) utility, the controller can report Ethernet cable problems, which means you can quickly determine whether you have a cable or motherboard problem and get on with the game.



Overclocking

ASUS added several overclocking-friendly features to the American Megatrends BIOS. We like CrashFree BIOS 2, which lets you repair a damaged BIOS by reinstalling the original BIOS from the motherboard's CD. We also like C.P.R. (CPU Parameter Recall), which activates when your computer freezes. When you reboot the system, C.P.R. resets the BIOS to its default settings. As a result, you won't need to use the CMOS jumper to clear your system. Non-overclockers will like Q-Fan. When your system isn't running intensive tasks, Q-Fan lowers your system fan speeds (it only affects fans that draw power directly from the motherboard), lowering your system's overall noise. The SK8V also includes the Windows-based BIOS update utility ASUS Update.

The SK8V included an old American Megatrends BIOS 2003 (ASUS Version 1001), so we upgraded the BIOS to ASUS Version 1002. The BIOS let us choose from a CPU voltage range of 1.5V to 1.7V. Users can also change the multiplier and adjust the AGP (1.5V to 1.7V) and DRAM (2.5V to 2.8V) voltages. As with the SK8N, the BIOS let us choose from a frequency range of 200MHz to 300MHz.

At default settings, the test system posted an impressive 6250 3Dmark03 score and a PCMark04 score of 4461. We pushed the CPU as high as 2.37GHz without any trouble, but the system refused to run either benchmark at 2.4GHz until we raised the voltage. At 1.55V, the system ran both benchmarks, posting an 83-point 3Dmark03 increase. The system ran the benchmarks at 2.44GHz with a VCore of 1.6V, but the BSOD strangled our system when we pushed it to 2.46GHz. Once we reinstalled Windows, we maxed the system out at 2.45GHz with a 1.7V VCore. The test PC posted a 3Dmark03 score of 6359 and a PCMark04 score of 4919, 458 points higher than its original score.

Overclock Comparison 3Dmark03

★ ASUS SK8V	
Stock Performance	6250
Overclocked Performance	6359
Gigabyte GA-K8NNXP-940	
Stock Performance	6204
Overclocked Performance	6300
ASUS SK8N	
Stock Performance	6150
Overclocked Performance	6248

Final Word

The SK8V trounced the other motherboards in our three-board lineup, offering the highest scores in both 3Dmark03 and PCMark04. It has a great accessories package and plenty of overclocking-friendly features. At $206, the SK8V isn't cheap, but it's the best FX-based motherboard we've seen.

by Joshua Gulick

AMD ATHLON 64 FX-51 & ASUS SK8N

The SK8V pounded through the benchmarks, so we hoped its older sibling could do the same. After all, ASUS has had more time to tweak the SK8N's once-flaky BIOS. As with the SK8V, we matched the SK8N with the 940-pin Athlon 64 FX-51. ASUS recently released a 939-pin version of the newer FX-53, but we don't expect to see a 939-pin FX-51.

Motherboard

The SK8N was one of the first AMD Athlon 64 FX-based motherboards to hit the market. It's also one of the only FX-based motherboards that sports NVIDIA's nForce3 pro-150 chipset. The board supports RAID 0, 1, and 0+1, and has a Promise R20378 controller. The SK8N arrived before Gigabit Ethernet became a standard feature, but the board does include a Realtek RTL8201 10/100 LAN controller. Realtek also provided the 6-channel ALC650 audio codec. A TI TSB43AB22A chip rounds out the board's most important chips, providing two internal FireWire headers. The board has a 940-pin CPU socket and supports AMD Athlon 64 FX and Opteron processors, but we doubt many users will slap an Opteron onto the board.

We found a boatload of accessories in the SK8N's sizeable box. The package includes two SATA cables, a dual-connector SATA PSU adapter, and a bunch of D-brackets. If you don't have many PCI cards, you'll love the D-brackets, which add ports but take up PCI slot bays. The brackets house two USB 2.0 ports, audio ports (including SPDIF-Out ports, a serial game port, and a FireWire port). We were disappointed to see that the FireWire bracket has only one FireWire port—we've seen many brackets that house both FireWire and USB ports. Half-empty brackets just waste space.

The motherboard doesn't include Windows-based overclocking software, but it does have several other programs, including InterVideo's WinDVD Suite (WinDVD, Win DVD Creator, and WinRip), Trend Micro PC-cillin, and several ASUS BIOS add-ons. The package also includes a printed user guide and a sticker that displays the board's jumpers and front panel connectors.

Unlike Athlon XP and 64-based motherboards, 940-pin FX-based motherboards require registered memory. As a result you can't use your old, unregistered memory when you upgrade to the SK8N. When shopping for new memory, keep in mind that most registered memory also includes ECC (error correction code), an unnecessary feature as far as FX-based motherboards are concerned (many servers use ECC memory). ECC slows system performance, so you'll want to disable the feature via the BIOS' Memory Configuration section. If you're not sure which memory to buy, take a look at the ASUS Web site's SK8N Overview section (usa.asus.com/products/mb/socket940/sk8n/overview.htm). The Web page lists dozens of ASUS-qualified DDR333 and DDR400 memory.

System Specs

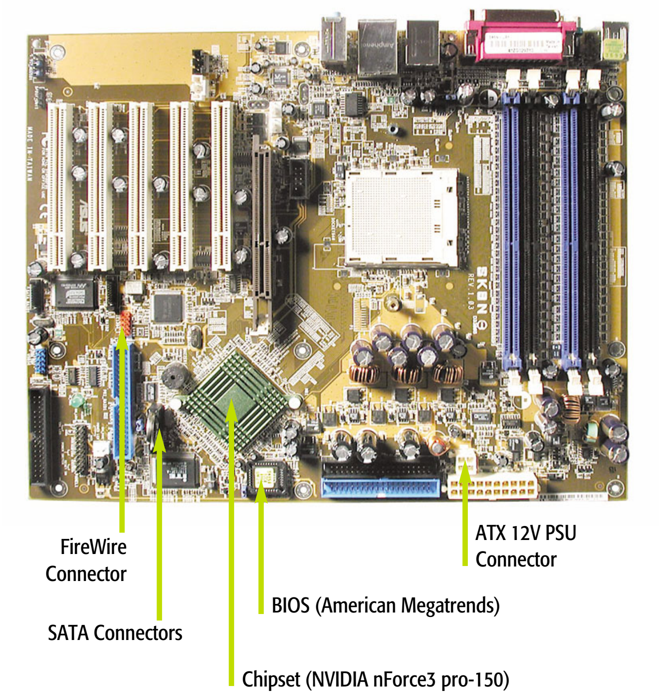
Processor, Motherboard & Drivers	
Processor	AMD Athlon 64 FX-51
Motherboard	ASUS SK8N
BIOS Manufacturer	American Megatrends
BIOS Version	AMI Bios 2003 ASUS Version 1007
Chipset Driver	NVIDIA v3.13 (nForce3 pro-150)
Common Components	
RAM	Corsair PC2700 registered DDR SDRAM (2 x 1GB)
Video	Gainward PowerPack! Ultra/1800 XP Golden Sample (GeForce FX 5950 Ultra)
Hard Drive	80GB Western Digital WD800JD 7,200rpm SATA
Heatsink	Thermalright SLK-948U
CPU Fan	pcToys 92mm Tornado
CD-ROM	LiteOn Black 48X/24X/48X/16X DVD/CD-RW
Floppy	Samsung 1.44MB
Power Supply	Antec 430W TruePower
Case	Antec PLUS1080AMG
Temperature Monitor	MacPower Digital Doc 5

After testing the Athlon 64-based motherboards, which didn't include performance-enhancing dual-channel memory technology, we were glad to see that the SK8N has four dual-channel slots. As a result, you can add up to two pairs of DIMMs to your system. Each pair must have identical DIMMS, but you don't need to use identical pairs. For example, you can use a pair of 256MB, PC3200 DIMMs and a pair of 512MB, PC3200 DIMMS. All told, the four slots support up to 8GB of registered DDR RAM.

Unfortunately, ASUS placed the nForce3 pro-150 chipset directly behind the 8X AGP slot. As a result, larger video cards hang over the chipset. You won't have any trouble installing your video card, thanks to the chipset's extremely short aluminum heatsink, but you won't be able to

AMD Athlon 64 FX-51 (ClawHammer)
ASUS SK8N

	Processor Speed	FSB	Multiplier	Voltage	Processor Temp	Case Temp	3Dmark03	PCMark04	PCMark04 CPU	PCMark04 Memory	PCMark04 Graphics	PCMark04 HDD
Stock Performance	2.2GHz	200MHz	11	1.5	34.2	28.4	6150	4147	4023	3274	4677	4221
Overclocked Performance	2.46GHz	224MHz	11	1.7	39.5	29.5	6248	4610	4489	3655	5461	4291

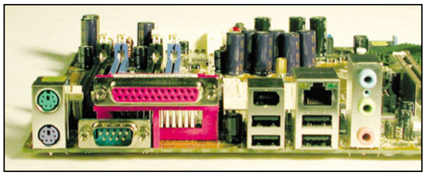


install a larger heatsink. Our only other gripe is that ASUS placed the power fan header right next to the CPU fan header. The headers are identical, so make sure you've plugged the CPU fan into the correct header before you fire up your system. If you do mix them up, we doubt you'll toast the CPU right away, but we weren't willing to try. We prefer risks that lead to rewards.

Aside from the chipset and fan headers, we like the board's layout. ASUS placed two of the board's three IDE connectors at the front of the board, near the system's optical and hard drives. The third IDE connector stands behind the five PCI slots. We were disappointed to see that the motherboard has only two SATA connectors. The SK8N has a single FireWire header; ASUS added the other FireWire port to the board's I/O riser. If your chassis has a front panel FireWire port, you'll probably want to ditch the FireWire D-bracket and attach the front panel connector to the internal header instead. In fact, you'll probably need to toss the USB D-bracket too, as the motherboard has only one USB 2.0 header. The I/O riser eats up the remaining four USB ports.

Overclocking

As with many other motherboard manufacturers, ASUS adds features to its BIOS. The SK8N includes several worthwhile features, but lacks C.P.R. (CPU Parameter Recall), which appears in the newer SK8V's BIOS. C.P.R. resets your system to default settings if your system freezes, which means you can recover from most overclocking-related problems by simply rebooting. C.P.R. isn't crucial, but it lets users avoid clearing the CMOS via motherboard's CMOS jumper. Luckily, you won't have any trouble reaching the CMOS jumper (ASUS also refers to it as the Real Time Clock RAM jumper), which stands just above the third IDE connector.



If you have several noisy system fans, you can enable the ASUS Q-Fan feature, which ratchets down your fan speeds when your system isn't under a full load. We like the CrashFree BIOS 2 feature, which lets you restore your BIOS from the driver CD. You can restore a damaged BIOS by simply inserting the CD and then rebooting the system.

When we last matched the SK8N with the FX-51 (see page 91 of *PC Modder*, Spring 2004), we wounded our poor motherboard by attempting to upgrade the American Megatrends 2003 BIOS from Revision 1001 to 1003. Our SK8N never fully recovered, so we bought a new SK8N for this test (which had Revision 1004) and then downloaded the latest BIOS: Revision 1007. The new BIOS took to our motherboard without any trouble, so we promptly benchmarked the system at default settings. The system performed well, scoring 6150 in 3Dmark03 and 4,147 in PCMark04.

Overclock Comparison 3Dmark03

ASUS SK8V	
Stock Performance	6250
Overclocked Performance	6359
Gigabyte GA-K8NNXP-940	
Stock Performance	6204
Overclocked Performance	6300
★ ASUS SK8N	
Stock Performance	6150
Overclocked Performance	6248

Next, we entered the BIOS. The CPU Configuration section has only two fields: CPU OverClock in MHz (200MHz to 300MHz) and CPU Voltage (1.5V to 1.75V). We left the VCore at 1.5V and raised the frequency. The 1.5V VCore let the system coast all the way to 2.4GHz (from its default setting of 2.2GHz), at which point our test PC posted a 3Dmark03 score of 6232 and a PCMark04 score of 4512. However, the system refused to boot at 2.42GHz until we boosted the VCore to a whopping 1.7 volts, just 0.05V shy of the board's max.

We finally maxed out our system at 2.46GHz with a 1.7V VCore. The test PC scored 6248 in 3Dmark03 and 4610 in PCMark04. The system booted at 2.49GHz and posted a 3Dmark03 score of 6265, but it was too unstable to handle PCMark04.

Final Word

Although we pushed our SK8N-based system to a slightly higher clock speed than the SK8V reached, the SK8N couldn't beat either of the other two boards' benchmark scores. That said, the SK8N is the least expensive board in our pack at $188, which means budget overclockers can put the extra cash towards other components. And unlike the Gigabyte GA-K8NNXP-940, the SK8N didn't have any trouble running PCMark04.

by Joshua Gulick

AMD Athlon 64 FX-51 & Gigabyte GA-K8NNXP-940

System Specs

Processor, Motherboard & Drivers	
Processor	AMD Athlon 64 FX-51
Motherboard	Gigabyte GA-K8NNXP-940
BIOS Manufacturer	American Megatrends
BIOS Version	V6.00PG (Gigabyte Version F3)
Chipset Driver	NVIDIA v3.13 (nForce3 150)
Common Components	
RAM	Corsair PC2700 registered DDR SDRAM (2 x 1GB)
Video	Gainward PowerPack! Ultra/1800 XP Golden Sample (GeForce FX 5950 Ultra)
Hard Drive	80GB Western Digital WD800JD 7,200rpm SATA
Heatsink	Thermalright SLK-948U
CPU Fan	pcToys 92mm Tornado
CD-ROM	LiteOn Black 48X/24X/48X/16X DVD/CD-RW
Floppy	Samsung 1.44MB
Power Supply	Antec 430W TruePower
Case	Antec PLUS1080AMG
Temperature Monitor	MacPower Digital Doc 5

So far, we've thrown VIA, NVIDIA, and SIS chipsets at every processor that we've tested. Unfortunately, motherboard manufacturers didn't adopt the SIS 755FX (the FX version of the chipset that graced our Athlon 64-based motherboards) until the 939-pin Athlon 64 FX CPU sockets arrived. We decided to look at another popular chipset that can handle the ultra-powerful FX: the NVIDIA nForce3 150. Although the nForce3 150 isn't certified for NVIDIA Quadro workstation graphics cards (NVIDIA generally targets the pro-150 at workstation users), it's just as capable of pushing the FX to its limits. We chose the Gigabyte GA-K8NNXP-940, which sports the nForce3 150 and a bunch of powerhouse features.

Motherboard

The GA-K8NNXP-940 supplements the NVIDIA nForce3 150 chipset with several Realtek peripheral chips, including an 8201 10/100 LAN controller, an 8110S Gigabit LAN controller, and an ALC658 (AC '97) codec that offers six-channel audio. The board also includes a FireWire controller and a GigaRAID ATA 133 RAID controller.

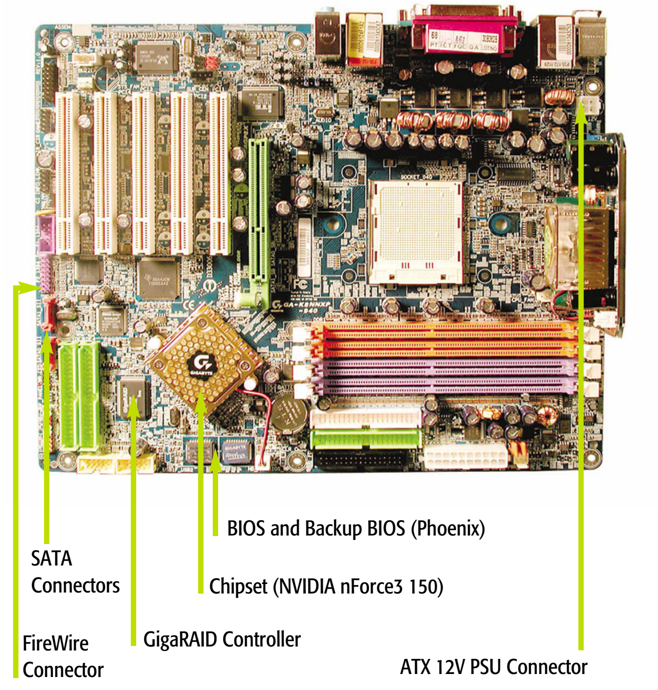
We found several accessories inside the box, including two SATA data cables with dust caps and two SATA PSU adapters. One of the adapters has only one hard drive connector, but the other adapter has two, so we're not complaining. Many of the motherboards we tested lacked even one PSU adapter, so we were glad to see Gigabyte go the extra mile. ASUS tossed three port-laden D-brackets into the box, including a bracket that sports a variety of audio ports and another bracket that holds both USB 2.0 and FireWire ports. A fourth D-bracket, which Gigabyte refers to as the GC-SATA card, has four SATA connectors and two power connectors. If you want to keep your SATA hard drives outside your computer, you can use this device to extend the board's SATA connectors to the back of the case. As always, Gigabyte added plenty of printed material to the package. The box includes a user guide, a large installation poster that has brief BIOS and utility explanations, a motherboard layout sticker that labels front-panel connectors, and a SATA RAID user guide.

Overall, we like the motherboard's layout. Thanks to a bunch of capacitors and the DPS (Dual Power System), the board has the most crowded CPU socket area we've seen, but we squeezed our giant Thermalright SLK-948U into the area without bumping any of the components. The nForce3 150, which has a large heatsink, stands behind the board's five PCI slots, unlike the ASUS SK8N's nForce3 pro-150 chipset, which stands directly behind the AGP slot. As a result, you can replace the GA-K8NNXP-940's chipset heatsink with any cooling system you like without blocking your video card. Another bonus that the SK8N lacks is the chipset's fan header. You can probably get by with a heavy-duty heatsink, but the further you push your system, the hotter your chipset will become, so we were glad to see that the included heatsink has a fan.

Thanks to the GigaRAID controller, the GA-K8NNXP-940's four IDE connectors support RAID 0, 1, or 0+1. Gigabyte placed two of the IDE connectors and the floppy connector near the memory slots, close to the optical and hard drives. The other two IDE connectors stand at the bottom of the board, just above the front-panel connectors. Two SATA connectors also stand below the IDE ports, next to the board's FireWire headers. Although the motherboard has

AMD Athlon 64 FX-51 (ClawHammer)
Gigabyte GA-K8NNXP-940

	Processor Speed	FSB	Multiplier	Voltage	Processor Temp	Case Temp	3Dmark03	PCMark04	PCMark04 CPU	PCMark04 Memory	PCMark04 Graphics	PCMark04 HDD
Stock Performance	2.2GHz	200MHz	11	1.5	33.2	27.5	6204	No Score	No Score	No Score	No Score	No Score
Overclocked Performance	2.46GHz	224MHz	11	1.65	35	27.2	6300	No Score	No Score	No Score	No Score	No Score



only two FireWire headers, you can connect up to three ports. One of the headers has extra pins that let the included FireWire D-bracket offer two ports. The standard FireWire header has a large, purple protective casing.

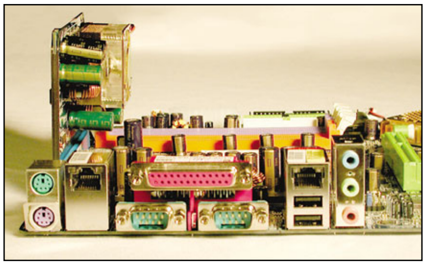
The GA-K8NNXP-940's four memory slots have dual-channel technology, which means you can boost your system's performance by adding an identical pair (or pairs) of DIMMs. The slots support up to 3GB of PC3200 DDR RAM. Keep in mind that, unlike standard Athlon 64-based boards, the 940-pin motherboards require registered memory. We used 2GB of Corsair PC2700 to test our FX-51 and FX-53 CPUs. Gigabyte's DPS, which has its own heatsink and LED fan, stands next to the memory. The DPS adds a three-phase power circuit to the board's built-in three-phase power circuit.

In addition to the standard PS/2 and serial ports, the I/O riser features the two LAN ports, complete with status indicator LEDs, two USB 2.0 ports, and three audio ports. Two internal USB 2.0 headers support up to four additional ports.

Overclocking

The GA-K8NNXP offers two overclocking tools: Dual BIOS and EasyTune4. If you overclock and flash enough motherboards, you'll eventually damage a BIOS. But if you toast the GA-K8NNXP-940's BIOS, you probably won't notice it, thanks to the board's two BIOS chips. If you damage the main 2MB chip, a spare 2MB chip automatically takes over, which means you won't need to reflash the BIOS or order a new chip. Although the Dual BIOS system doesn't speed up any of your components, it saves time.

Users who are new to overclocking will like EasyTune4. The Windows-based overclocking software lets you adjust a variety of settings without entering the BIOS, including processor clock speed and voltage. If you want to dabble with other components, you can use the software to change memory and AGP voltages. In our experience, Windows-based overclocking software doesn't push a processor to its limits, so we entered the most important overclocking tool: the computer's BIOS.



Overclock Comparison 3Dmark03

ASUS SK8V	
Stock Performance	6250
Overclocked Performance	6359
★ Gigabyte GA-K8NNXP-940	
Stock Performance	6204
Overclocked Performance	6300
ASUS SK8N	
Stock Performance	6150
Overclocked Performance	6248

The BIOS lets you adjust the CPU frequency (200MHz to 300MHz) and the DRAM (2.5V to 2.8V) and VCore (0.8V to 1.7V) voltages. You can also adjust the multiplier. Once we located the appropriate settings, we backed out of the BIOS, rebooted the test system, and then ran the benchmarks. At 2.2GHz, the system posted a 3Dmark03 score of 6204 but refused to load PCMark04. We tried everything we could think of, including a rain dance, but the board denied PCMark04 every time. That said, the system was clearly stable. It posted strong 3Dmark03 benches without a problem and handled every other task we threw at it. After toasting two GA-K8VNXP's in a row, we were just glad this particular board wasn't on fire.

At 2.42GHz, the motherboard bailed out of 3Dmark03, so we upped the voltage to 1.55V, which carried the board only to 2.44GHz. We finally maxed out the test PC at 2.46GHz with a 1.65V VCore. The system posted a 3Dmark03 score of 6300—that's only 96 points higher than its original score, but it did manage to reach 52 points higher than the SK8N's max score.

Final Word

Aside from not loading PCMark04, the $214 GA-K8NNCP-940 performed reasonably well. We were disappointed that we couldn't make use of the VCore's 1.7V ceiling, but we like the board's 3Dmark03 scores, which put it directly between the SK8N and the score-thumping SK8V. We also like this motherboard's accessories package and its Dual BIOS system. If you want the highest benchmark scores, you'll probably want to look at the $206 ASUS SK8V, but we think you'll enjoy overclocking either of these boards.

by Joshua Gulick

NEED SPEED?

We Test 10 Video Cards To See Which Is Fastest

Imagine yourself ensconced in your favorite video game chair playing the latest 3D game. Your significant other walks into the room, takes a good look at the action on the screen, and says, "What movie is this?"

We might not be there just yet, but if the graphics chip industry stays as competitive has it has been lately, true cinema-quality gaming isn't terribly far away. (Even today, the preceding scenario is not entirely unlikely.)

Competition within the graphics industry has, at least modestly, eased prices of video cards. Today's high-end cards will soon be tomorrow's midrange cards. For the following case studies, we tested a handful of midrange cards based on ATI and NVIDIA GPUs to help you find one that best matches your current gaming needs without blasting a hole through your budget at the same time. At the time of this writing, Half-Life 2 still hasn't hit store shelves, but all of the cards we tested offer DX9 capabilities and AGP 8X. And almost just as important, only one of the cards, the Sapphire ATI Radeon 9800 PRO, cost us more than $200.

Don't expect these cards to match the unprecedented features of NVIDIA's GeForce 6 series or ATI's Radeon X800 PRO (to read a head-to-head review of ATI and NVIDIA's most powerful chips, turn to page 108), but some of them will no doubt suffice for those of you seeking fast frame rates at high-end resolutions, and more than a few of the cards offer a bit of eye candy, too.

There's no better time than now to start saving if you want to be ready for the day when photo-realistic gaming arrives. But until then, rest assured, mid-rangers: You don't have to sacrifice performance for value, and the proof lies within the following pages.

How We Tested

We started by choosing an array of ATI and NVIDIA chips with roughly equivalent GPUs and then purchased an assortment of cards from varying manufacturers. ASUS, Sapphire, ATI, BFG, AOpen, ABIT, and eVGA are all represented here—some more than others.

We tested each card with the latest drivers available: Catalyst 4.4 for ATI-powered cards and ForceWare 56.72 for NVIDIA-equipped cards. We built the Windows XP Pro test system to stretch each card to the limit, using a 2GHz AMD Athlon 64 3200+, 1GB (2 x 512MB) of Kingston HyperX PC3200 DDR RAM affixed to an ASUS K8V Deluxe motherboard (equipped with Via's K8T800 chipset), a Seagate Barracuda ST380013AS 80GB SATA hard drive, and a Lite-On Black LTC-48161H 48X/24X/48X/16X DVD/CD-RW drive. The system had an Antec Original TRUE 430W P4 power supply.

For our game frame-rate tests, we used our usual benchmarking tools, including Quake II Arena (which we ran at two resolutions: 1,024 x 768 and 1,600 x 1,200) and Futuremark's 3DMark2001 SE and 3DMark03. NVIDIA has received a lot of flack (and perhaps rightfully so) for using "optimizations" in 3DMark03 that inflated its scores by up to 30%. We eliminated that handicap with Futuremark's 340 patch (designed to eliminate optimizations on 3D cards).

We also ran tests with AquaMark3, Halo, Unreal Tournament 2003, and Unreal Tournament 2004.

While testing with AquaMark3, we maintained the program's default resolution of 1,024 x 768. For the Halo tests, we ran two demos at 1,600 x 1,200. The first demo was run without AA and AF; the second was run with all AA and AF at full. We then ran Unreal Tournament 2003's Anatalus and Phobos 2 demos at two different resolutions: 1,024 x 768 and 1,600 x 1,200.

Finally, we ran our own time demo in Unreal Tournament 2004. To do that, we recorded one minute of game play in the DeathMatch DesertIsle platform. We then restarted the game, re-entered the console, and enabled demo play. Our game was subsequently replayed in real-time, giving us the necessary results to calculate frames per second (number of frames divided by number of seconds played). The same demo was used for each test.

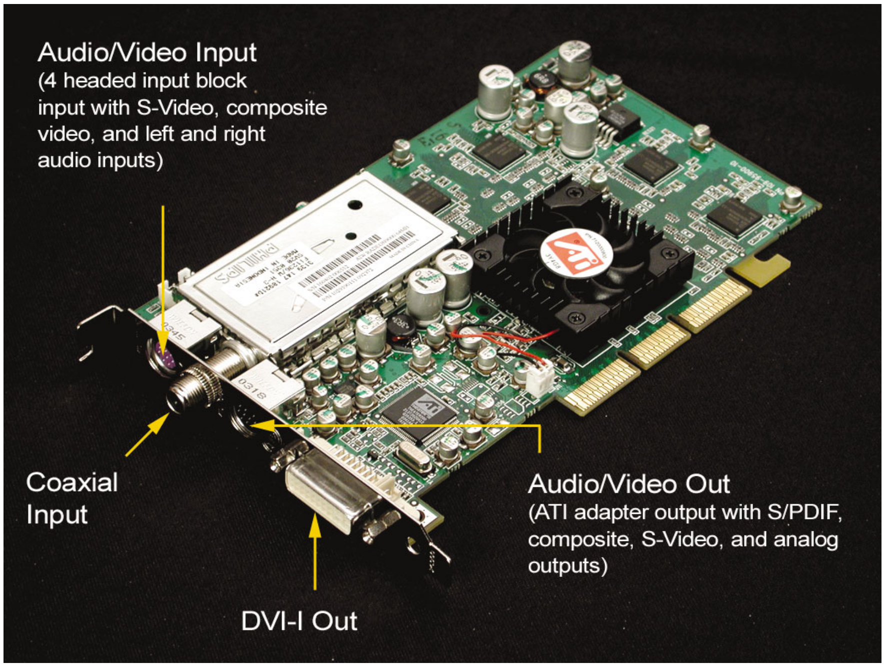
(One small caveat: Some of the UTK4 scores came out a little fishy, with a few cards even garnering the same score. We print them here so you can make your own decisions about their value.)

For the gripping finale, lab tester and video card maven Andy "Tortuga" Gerace overclocked each card to its stable maximum core clock and memory clock speeds and reran 3Dmark 2001, 3Dmark03, and AquaMark3.

And to offset the possibility that benchmarks aren't everything, we selflessly engaged ourselves in hours of grueling real-life game play with UT2K4, Soldier Of Fortune II, and a host of other subjective "utilities." CPU

by Eric Melvin Reed

ATI ALL-IN-WONDER RADEON 9000 PRO


Audio/Video Input
(4 headed input block input with S-Video, composite video, and left and right audio inputs)
Coaxial Input
DVI-I Out
Audio/Video Out
(ATI adapter output with S/PDIF, composite, S-Video, and analog outputs)

ATI crafted its All-In-Wonder series for PC users looking to add TV functionality to their desktop PCs, and by providing a bevy of accessories, it has managed to put together a family of graphics cards that have simply eclipsed the competition—even if that means the cards sometimes sacrifice VPU speed for the sake of sundry multimedia features.

The All-In-Wonder 9000 PRO is no exception to the AIW series: It offers a first-rate list of multimedia features, such as DVD, TV-on-PC, and PVR capabilities. Yet its graphics capabilities lay somewhere in the median to submedian range.

Those looking to play the latest DirectX 9 games might feel let down by this card's DirectX 8.1 capabilities, mere AGP 4X support, and humble 64MB of DDR RAM. During our lab and overclocking tests the card provided middling scores. Not even the fact that the AIW 9000 PRO outperformed the ATI Radeon 9200 in nearly all the tests we ran—all the tests, that is, except for the Halo tests, which we ran at a 1,600 x 1,200 resolution with and without AA and AF at full—can hide the fact that the card's 3DMark 2001 SE, 3DMark03, and AquaMark3 scores are average at best (8893, 1443, and 14275, respectively), even for a cost-effective, upper-end AIW card.

Make no mistake, multimedia functionality is the AIW 9000 PRO's forte, and in that category the card doesn't disappoint. We purchased our card for $143, but it can probably be had for a lot cheaper. You might even be able to find one for under $100. For that price you'll get a full stack of features and accessories. All the hardware you need to convert your PC into multimedia center is present, including a four-headed input block with S-Video, composite video, and left and right audio inputs; DVI-I to VGA adapter; adapter output cable with SPDIF, composite, S-Video, and analog audio outputs; and a RF remote control with batteries and USB remote receiver.

Video/display feature highlights include the Thruview feature, which provides translucent viewing of TV, DVD, and video and lets you access your Desktop from your TV without moving the TV window, and TV-On-Demand for pausing live TV and recording live broadcasts.

The card uses ATI's Multimedia Center version 8.1 and ATI's Truform, Smartshader, and Smoothvision technologies. Our package included Pinnacle's Studio 8 software (ATI version).

ATI backs the AIW 9000 PRO with a three-year limited warranty.

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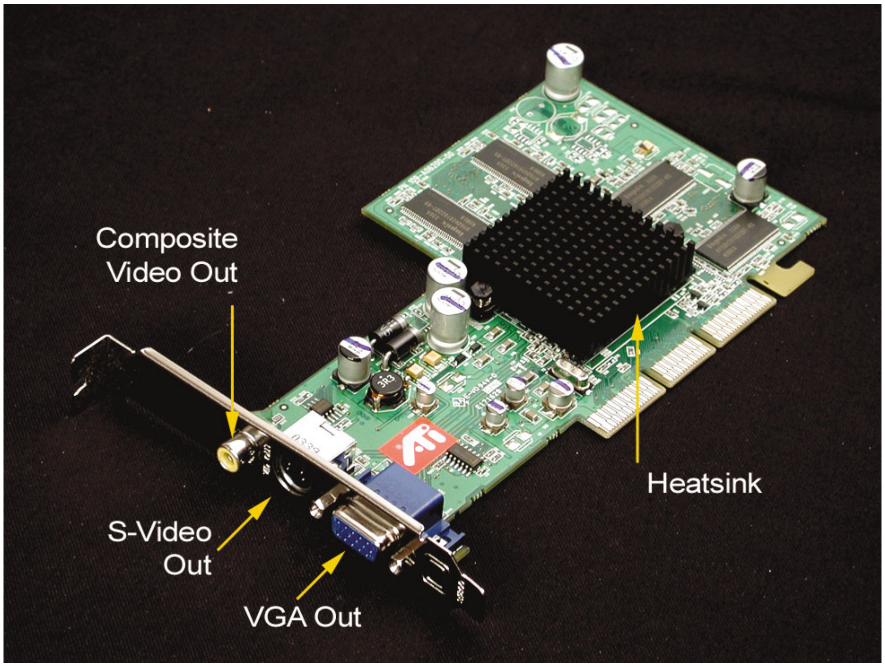
by Eric Melvin Reed

Vital Statistics

Video Card	ATI AIW Radeon 9000 PRO
Interface	AGP 4X
Chipset	Radeon 9000 PRO
RAM	64MB DDR
Core Clock	275MHz
Memory Clock Actual (Effective)	270MHz (540MHz)
Overclocked Maximums (core clock/memory clock in megahertz)	300/295
Max. Resolution	2,048 x 1,536
Refresh Rate at Max. Resolution	85Hz
APIs Supported	DirectX 8.1, OpenGL
Operating Systems	Win98/98SE/Me/2000/XP
3DMark2001 SE	
3D Marks [overclocked]	8893 [9592]
Fill Rate (single texture)	728.6
Fill Rate (multitexture)	1087.2
3DMark03	
3D Marks [overclocked]	1443 [1551]
Fill Rate (single texture)	709.1
Fill Rate (multitexture)	1076.7
Quake III Arena at 32-bit	
1,024 x 768	170.3
1,600 x 1,200	74.8
Unreal Tournament 2003 at 32-bit (average fps)	
Anatalus 1,024 x 768	59.1
Anatalus 1,600 x 1,200	23.7
Phobos2 1,024 x 768	42.2
Phobos2 1,600 x 1,200	22.3
Unreal Tournament 2004 at 32-bit*	
1,600 x 1,200	24.74
AquaMark3 at 32-bit	
Default Test [overclocked]	14275 [15436]
GFX [overclocked]	1547 [1685]
CPU [overclocked]	9248 [9237]
Halo	
1,600 x 1,200	7.97
1,600 x 1,200 (AA/AF at full)	7.09
Phone	(905) 882-2600
URL	www.ati.com

*Custom Demo: DeathMatch DesertIsle map

ATI RADEON 9200



> These days, a lot of graphics cards are loaded down with excessive features and phony advertising.

The good news: ATI's Radeon 9200 is one of the cheapest cards we tested, ringing up at just $92. The bad news: You get what you pay for.

On the bright side, the card is only slightly slower than the GeForce FX 5200 Ultra. The Asylum GeForce FX 5200 Ultra that we tested put the Radeon 9200 to shame in our Unreal Tournament 2003 Anatalus and Phobos2 tests, Halo tests, and 3DMark2001 SE and 3DMark03 tests. (Due to planetary misalignment, negative chakra energy, and possibly bad salmon pate, the 9200's AquaMark3 scores were inconclusive.)

As far as physical appearance goes, this cut-rate card bears an even cheaper look, with a tiny heatsink and a bland green, L-shaped design. (But hey, at least it's light.)

The card offers VGA, composite, and S-Video output for connecting to a TV or VCR. It also features ATI's Smoothvision, Video Immersion II (for DVD and digital TV decoding capabilities), and Pixel Tapestry II, as well as Smartshader technologies. However, it does not feature Smartshader 2.1, meaning in part that although the card does support DX8.1 and is compatible with some of the most recent DX9 games, you shouldn't expect the Radeon 9200 to support DX9-specific features.

Likewise, don't expect the card to reach soaring resolutions. During our own real-time game play, Unreal Tournament 2004 was virtually unplayable with the Radeon 9200 at the highest possible resolution of 1,920 x 1,200. And at a resolution of 1,600 x 1,200, we still experienced occasional stuttering. Fortunately, at the acceptable (if mediocre) resolution of 1,280 x 1,024, the game ran at a satisfactory clip.

These days, a lot of graphics cards are loaded down with excessive features and phony advertising. But the 9200 doesn't try to be anything it's not. It's simply a value-class AGP 8X card that delivers second-rate but nonetheless sufficient graphics. If, as it has been suggested, the majority of video cards buyers are people looking to while away a few week-end hours on the latest generation of games (and are not hard-core gamers), then the Radeon 9200 will find a suitable niche in the graphics card market—if it hasn't already.

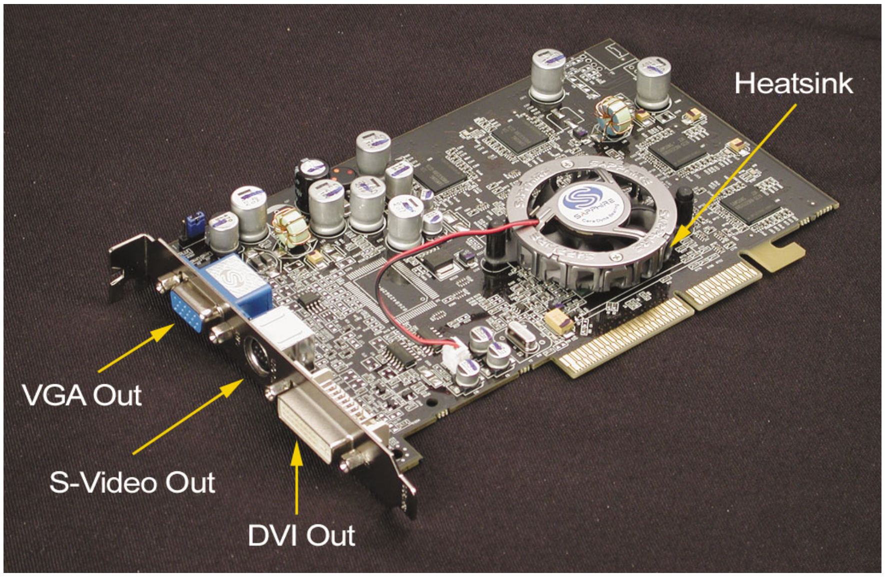
by Eric Melvin Reed

Vital Statistics

Video Card	ATI Radeon 9200
Interface	AGP 8X
Chipset	Radeon 9200
RAM	128MB DDR
Core Clock	250MHz
Memory Clock Actual (Effective)	216MHz (432MHz)
Overclocked Maximums (core clock/memory clock in megahertz)	290/230
Max. Resolution	2,048 x 1,536
Refresh Rate at Max. Resolution	85Hz
APIs Supported	DirectX 8.1, OpenGL
Operating Systems	Win98/98SE/Me/2000/XP
3DMark2001 SE	
3D Marks [overclocked]	7352 [8264]
Fill Rate (single texture)	554.4
Fill Rate (multitexture)	989.9
3DMark03	
3D Marks [overclocked]	1223 [1358]
Fill Rate (single texture)	520.4
Fill Rate (multitexture)	978
Quake III Arena at 32-bit	
1,024 x 768	145
1,600 x 1,200	63.8
Unreal Tournament 2003 at 32-bit (average fps)	
Anatalus 1,024 x 768	48.9
Anatalus 1,600 x 1,200	21.9
Phobos2 1,024 x 768	64.3
Phobos2 1,600 x 1,200	32.6
Unreal Tournament 2004 at 32-bit*	
1,600 x 1,200	22.2
AquaMark3 at 32-bit	
Default Test	N/A
GFX [overclocked]	N/A
CPU [overclocked]	N/A
Halo	
1,600 x 1,200	7.32
1,600 x 1,200 (AA/AF at full)	6.37
Phone	(905) 882-2600
URL	www.ati.com

*Custom Demo: DeathMatch DesertIsle map

SAPPHIRE ATI RADEON 9600 PRO



For some people, the extras that come with graphics cards are almost as important as the cards themselves. When ATI decided to package the Radeon 9600 XT with a full version of Half-Life 2 (or a coupon for the full version when it is available), for example, even some of the staunchest NVIDIA fans were enticed into giving the card a try.

Unfortunately for those same people, the Sapphire ATI Radeon 9600 PRO we purchased for $129.50 (OEM) will be a major disappointment. Sapphire left us without a single extra to talk about.

On the other hand, however, we can talk about the card's performance capabilities, which lay somewhere in the middle of the midrange pack. Let's start with the benchmarking results. The 9600 PRO registered scores of 12453 in 3DMark2001 SE tests and 3426 in 3DMark03 tests. By comparison, the ABIT Siluro FX5600 Ultra OTES that we tested scored 12961 and 3245. In AquaMark3 tests, the 9600 PRO produced a default score of 26418 and an overclocking score of 29810. However, we were able to raise the card's core clock and memory clock from 400/300 to 450/335 during overclocking. The FX5600 Ultra, which we overclocked at 475/875 over its core clock and memory clock speeds of 425/825, scored 22544 and 26285 in the same tests, giving the 9600 PRO a slight advantage.

Of course, when compared to something like the ATI Radeon 9800 PRO, the numbers posted by the 9600 PRO look a lot more modest. That shouldn't surprise anyone, but what is surprising is how well the 9600 PRO holds up during actual game play. Although the card doesn't offer any exciting hardware features, it is by no means a dinosaur. 3D-enchancing features include AGP 8X, DX9, and OpenGL support; Smartshader 2.1 and Smoothvision 2.1 technology; the Videoshader engine; and ATI's Fullstream technology. We played some Soldier of Fortune II: Double Helix and also invested a fair amount of time playing Unreal Tournament 2004 with all the relevant settings cranked to their highest levels (that does not include antialiasing). Except for the occasional jerking on the most video-intensive levels, the card deserves credit for its speedy performance.

Our test unit had VGA, S-Video, and DVI outputs, but the list of features stops there. The card is not as fast as a $400 or $500 card, but it might be pertinent to restate that this is a midrange OEM card. Keeping that in mind—and assuming that some people don't mind a lack of complementary bells and whistles—the Radeon 9600 PRO is a winner. CPU

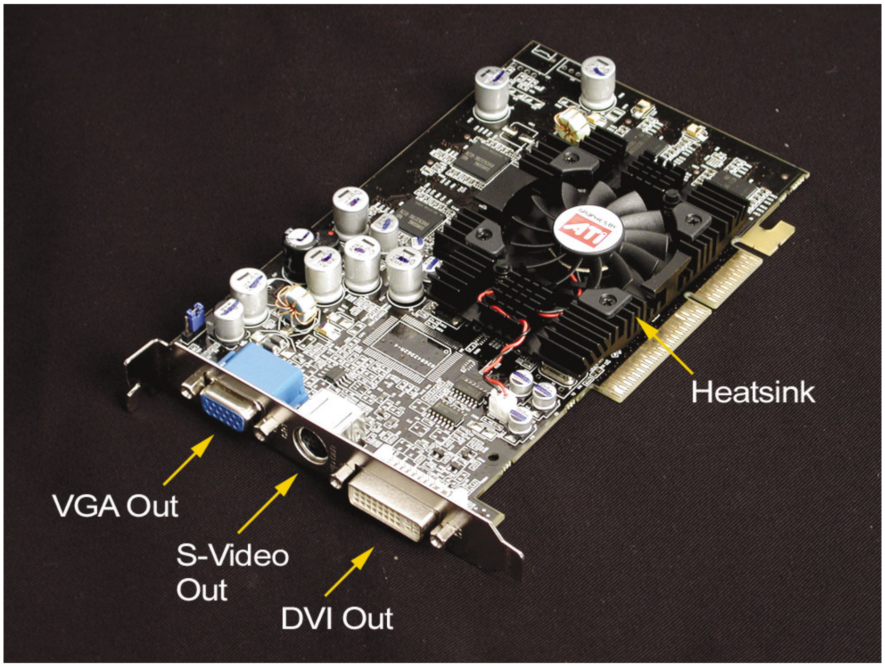
by Eric Melvin Reed

Vital Statistics

Video Card	Sapphire ATI Radeon 9600 PRO
Interface	AGP 8X
Chipset	ATI Radeon 9600 Pro
RAM	128MB DDR
Core Clock	400MHz
Memory Clock Actual (Effective)	300MHz (600MHz)
Overclocked Maximums (core clock/memory clock in megahertz)	450/335
Max. Resolution	2,048 x 1,536
Refresh Rate at Max. Resolution	85Hz
APIs Supported	DirectX 9.0, OpenGL
Operating Systems	Win98/Me/2000/XP
3DMark2001 SE	
3D Marks [overclocked]	12453 [13872]
Fill Rate (single texture)	1021.7
Fill Rate (multitexture)	1578
3DMark03	
3D Marks [overclocked]	3426 [3859]
Fill Rate (single texture)	902.5
Fill Rate (multitexture)	1565.3
Quake III Arena at 32-bit	
1,024 x 768 [overclocked]	251.7 [90.4]
1,600 x 1,200 [overclocked]	113.8 [41.3]
Unreal Tournament 2003 at 32-bit (average fps)	
Anatalus 1,024 x 768	101.8
Anatalus 1,600 x 1,200	42.7
Phobos2 1,024 x 768	124.8
Phobos2 1,600 x 1,200	57.8
Unreal Tournament 2004 at 32-bit*	
1,600 x 1,200	25.31
AquaMark3 at 32-bit	
Default Test [overclocked]	26418 [29810]
GFX [overclocked]	3080 [3566]
CPU [overclocked]	9114 [9079]
Halo	
1,600 x 1,200	13.29
1,600 x 1,200 (AA/AF at full)	11.38
Phone	(909) 594-0597
URL	www.sapphiretech.com

*Custom Demo: DeathMatch DesertIsle map

SAPPHIRE ATI RADEON 9600 XT



To call Sapphire's ATI Radeon 9600 XT reliable is not to say that it is also boring. Although it's true that the package leaves us without any mouthwatering goodies to talk about, it's equally as true that the card offers exceptionally good performance capabilities. And let's be honest, is there really anything more important than performance?

The 9600 XT posted precisely the sort of numbers during testing that you might expect from one of ATI's higher-end midrange cards, which is what the card is. Take, for example, the 3DMark2001 SE and 3DMark03 scores we got of 13793 and 3834. Consider also the AquaMark3 score of 31285 and the Halo scores of 15.77 at 1,600 x 1,200 and 13.61fps at the same resolution with all AA and AF set to full. In comparison, the Sapphire ATI 9600 PRO we tested offered just 11.38fps with full AA and AF.

Sapphire let us down by not including an attractive software bundle (the driver CD is the only disc in the package), especially considering that the full retail version of the Atlantis Radeon 9600 XT at Sapphire's Web site is bundled with Half-Life 2 (as soon as the game is released). However, the company at least included a DVI-to-VGA connector and S-Video-to-composite cable to accompany the card's VGA, S-Video, and DVI outputs.

We purchased the 9600 XT at retail for $152. (The OEM 9600 PRO we tested cost us $129.50.) For the few extra bucks, you get the satisfaction of knowing you have ATI's third-generation VPU, as well as ATI's Smartshader 2.0 and Smoothvision 2.1 technology. What's more, you don't have to worry about the card's speed. When overclocked, the 9600 XT reached a core clock speed of 525MHz, up from its core VPU clock of 500MHz. The memory clock speed bumped up to 310 from 300, making the 9600 XT a slightly better overclocked card than the 9600 PRO. But even without the extra boost, the 9600 XT is still a great value. With it, there wasn't a game we weren't able to play.

Although the card doesn't have an external power connector, if you're looking to play the latest DX9-class games, the 9600 XT offers all the power you need. In a market where series numbers don't exactly give an accurate indication of a card's merit, to call the 9600 XT reliable is a supreme compliment. If you don't have the money to purchase something such as ATI's Radeon 9800 SE, the 9600 XT is a great alternative.

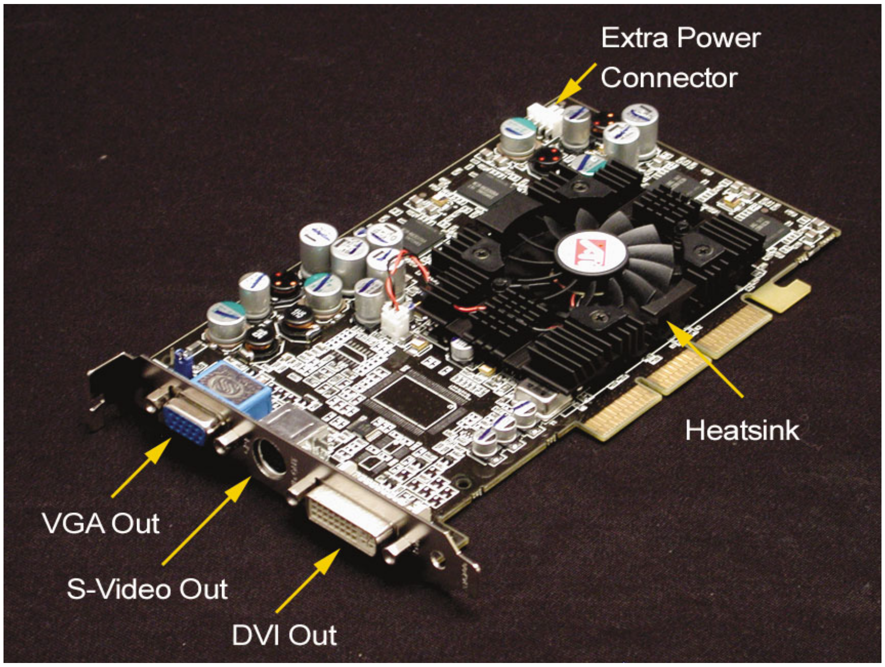
by Eric Melvin Reed

Vital Statistics

Video Card	Sapphire ATI Radeon 9600 XT
Interface	AGP 8X
Chipset	ATI Radeon 9600 XT
RAM	128MB DDR
Core Clock	500MHz
Memory Clock Actual (Effective)	300MHz (650MHz)
Overclocked Maximums (core clock/memory clock in megahertz)	525/310
Max. Resolution	2,048 x 1,536
Refresh Rate at Max. Resolution	85Hz
APIs Supported	DirectX 9.0, OpenGL
Operating Systems	Win98/Me/NT4/2000/XP
3DMark2001 SE	
3D Marks [overclocked]	13793 [14269]
Fill Rate (single texture)	1042
Fill Rate (multitexture)	1968
3DMark03	
3D Marks [overclocked]	3834 [4024]
Fill Rate (single texture)	914
Fill Rate (multitexture)	1924
Quake III Arena at 32-bit	
1,024 x 768	264.3
1,600 x 1,200	125.7
Unreal Tournament 2003 at 32-bit (average fps)	
Anatalus 1,024 x 768	110.8
Anatalus 1,600 x 1,200	45.5
Phobos2 1,024 x 768	134.1
Phobos2 1,600 x 1,200	61.9
Unreal Tournament 2004 at 32-bit*	
1,600 x 1,200	25.23
AquaMark3 at 32-bit	
Default Test [overclocked]	31285 [32777]
GFX [overclocked]	3788 [4004]
CPU [overclocked]	8984 [9030]
Halo	
1,600 x 1,200	15.77
1,600 x 1,200 (AA/AF at full)	13.61
Phone	(909) 594-0597
URL	www.sapphiretech.com

*Custom Demo: DeathMatch DesertIsle map

SAPPHIRE ATI RADEON 9800 SE



Sapphire's international influence is evidenced by the fact that the box in which our card shipped features text in no fewer than five languages. With the company so seemingly well-entrenched in Europe, you have to wonder why the company has been so slow to amass a following in the United States.

One of the reasons could be the company's ATI Radeon 9800 SE. Our test unit produced some very disappointing benchmarking scores, such as 13611 in 3Dmark2001 SE, 3315 in 3Dmark03, and 24679 in AquaMark3. It's not that those scores are substandard, per se; they're just not what you might expect from a Radeon 9800. Each of the scores listed were lower than those hammered out by ATI's Radeon 9600 XT, leading us to think that if the card had been made by ATI it would be a lot faster.

After squeaking by with such meager results in 3Dmark2001 SE, 3Dmark03, and AquaMark3 tests, the card posted scores of 11.11 in Halo, 37.1 in the UT2003 Anatalus test, and 51fps in Phobos2 at a resolution of 1,600 x 1,200 again, each score was lower than the ones posted by ATI's Radeon 9600 XT.

Fortunately, this four-pipeline VPU card makes up for its somewhat disappointing scores by exhibiting some nice overclocking potential. We were able to increase the core clock speed and memory speed from 325MHz to 380MHz and 290MHz to 340MHz, at which point the card's 3Dmark2001 SE and 3Dmark03 scores shot up to 15813 and 4049. Its AquaMark3 scores rose to 30428.

At this point, NVIDIA fans might be inclined to point out that even when overclocked, the Sapphire ATI Radeon 9800 SE pales next to the PNY GeForce FX5900 SE at its core clock speed and memory speed, and frankly, there are quite a few cards that offer better performance than this one, but not many go for the same price ($136 OEM). Nor do they come with an S-Video cable and a Y-adapter power cable.

During real-time game play, the card showed that it is powerful enough to fully support DX9 games. Buying the 9800 SE from Sapphire is like purchasing a 9600 XT or even a 9600 PRO, but at a much better price and without the software bundle. As long as you don't expect the Sapphire ATI Radeon 9800 SE to perform on par with other higher-end or upper middle-end cards, and if you want to play DX9 and OpenGL 2.0 games at decent resolutions, this card is worth the small dent it will put in your pocketbook. CPU

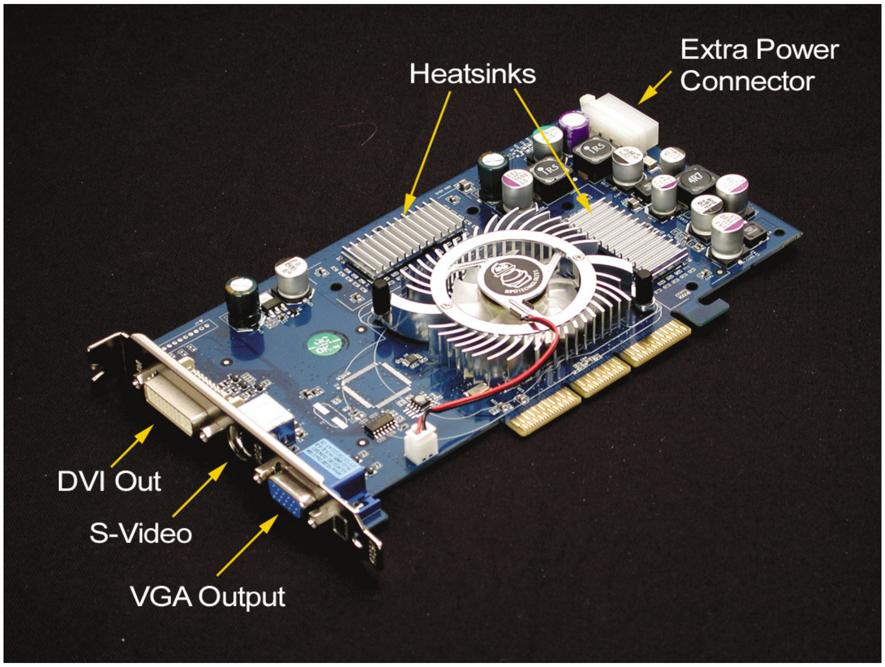
by Eric Melvin Reed

Vital Statistics

Video Card	Sapphire ATI Radeon 9800 SE
Interface	AGP 8X
Chipset	ATI Radeon 9800 SE
RAM	128MB DDR
Core Clock	325MHz
Memory Clock Actual (Effective)	290MHz (580MHz)
Overclocked Maximums (core clock/memory clock in megahertz)	380/340
Max. Resolution	2,048 x 1,536
Refresh Rate at Max. Resolution	85Hz
APIs Supported	DirectX 9.0, OpenGL
Operating Systems	Win98SE/Me/NT4/ 2000/XP
3DMark2001 SE	
3D Marks [overclocked]	13611 [15813]
Fill Rate (single texture)	991.5
Fill Rate (multitexture)	1288.5
3DMark03	
3D Marks [overclocked]	3315 [4049]
Fill Rate (single texture)	924.4
Fill Rate (multitexture)	1280.1
Quake III Arena at 32-bit	
1,024 x 768	239.2
1,600 x 1,200	92.7
Unreal Tournament 2003 at 32-bit (average fps)	
Anatalus 1,024 x 768	88.1
Anatalus 1,600 x 1,200	37.1
Phobos2 1,024 x 768	110.7
Phobos2 1,600 x 1,200	51
Unreal Tournament 2004 at 32-bit*	
1,600 x 1,200	26.1
AquaMark3 at 32-bit	
Default Test [overclocked]	24674 [30428]
GFX [overclocked]	2852 [3653]
CPU [overclocked]	9130 [9082]
Halo	
1,600 x 1,200	11.11
1,600 x 1,200 (AA/AF at full)	9.41
Phone	(909) 594-0597
URL	www.sapphiretech.com

*Custom Demo: DeathMatch DesertIsle map

BFG TECHNOLOGIES ASYLUM GEFORCE FX 5200 ULTRA



The Asylum GeForce FX 5200 Ultra from BFG Technologies is one of the stingiest cards we tested with NVIDIA chips, but at $99 (retail) it was, at least, the least expensive.

When overclocked, the card showed 4% and almost 12% gains in 3DMark2001 SE and 3DMark03 tests, respectively. In AquaMark3 default tests, the card showed even more spunk, with nearly 16% gains. Those scores were still well below other cards' scores. Take, for instance, the FX 5600 Ultra. The FX 5200 Ultra's overclocking score of 2243 in 3DMark03 registered dismally below the FX 5600 Ultra's stock score of 3245. To be fair, of course, the 5600 Ultra carries a higher price tag of almost $200. So as far as benchmarks go, this is a case of getting what you pay for.

But we all know that benchmarking isn't the only way to measure a video card. During real-life game play tests, the Asylum GeForce FX 5200 Ultra neither broke our backs nor rocked our canoes. In fact, during actual game play with Unreal Tournament 2004, the FX 5200 Ultra functioned admirably at all but the highest resolutions. Although the card supports only a maximum resolution and refresh rate of 2,048 x 1,536 and 60Hz at 16-bit, that's still enough to satisfy most gamers.

One of the card's more notable features is support for NVIDIA CineFX shading architecture. That won't surprise many of you, as the CineFX engine is a cornerstone of the GeForce FX line. (On the other hand, the card doesn't support NVIDIA's Intellisample anti-aliasing feature.)

Unfortunately, this card's list of extras doesn't extend much beyond NVIDIA's NVDVD 2.0 software, a lifetime warranty with online and toll-free telephone tech support, and a few NVIDIA GeForce FX and GeForce 4 Demos.

A word or two about the card's exterior: The Asylum GeForce FX 5200 Ultra is a sleek, slim, teal-colored card with two small heatsinks, an extra power connector, and DVI, S-Video, and VGA outputs. A DVI-to-VGA connector is included in the box.

For less than a hundred bucks, the Asylum GeForce FX 5200 Ultra gives you an unpretentious card stripped of eye candy. But it's difficult to say how far into the future this card can take you. If you can afford it, spend a little more and get yourself something that's more likely to last. Or, if you're really patient, wait six months and get an even better card for the same price.

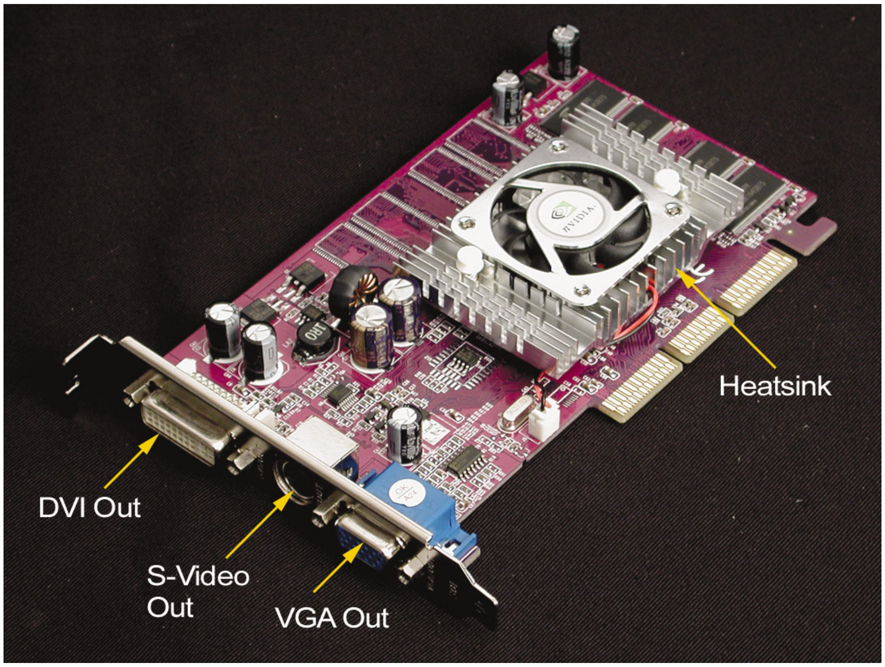
by Eric Melvin Reed

Vital Statistics

Video Card	BFG Technologies Asylum GeForce FX 5200 Ultra
Interface	AGP 8X
Chipset	GeForce FX 5200 Ultra
RAM	128MB DDR
Core Clock	325MHz
Memory Clock Actual (Effective)	325MHz (650MHz)
Overclocked Maximums (core clock/memory clock in megahertz)	375/700
Max. Resolution	2,048 x 1,536 (16-bit)
Refresh Rate at Max. Resolution	60Hz
APIs Supported	DirectX, OpenGL
Operating Systems	Win95 OSR2/98/Me/2000/NT4 with SP 5 or 6/XP
3DMark2001 SE	
3D Marks [overclocked]	10303 [10741]
Fill Rate (single texture)	913.2
Fill Rate (multitexture)	949.7
3DMark03	
3D Marks [overclocked]	2005 [2243]
Fill Rate (single texture)	948.9
Fill Rate (multitexture)	921.7
Quake III Arena at 32-bit	
1,024 x 768	247.9
1,600 x 1,200	115.8
Unreal Tournament 2003 at 32-bit (average fps)	
Anatalus 1,024 x 768	73.5
Anatalus 1,600 x 1,200	31.4
Phobos2 1,024 x 768	81.4
Phobos2 1,600 x 1,200	37.7
Unreal Tournament 2004 at 32-bit*	
1,600 x 1,200	24.82
AquaMark3 at 32-bit	
Default Test [overclocked]	11360 [13129]
GFX [overclocked]	1208 [1412]
CPU [overclocked]	9299 [9309]
Halo	
1,600 x 1,200	8.92
1,600 x 1,200 (AA/AF at full)	7.73
Phone	(847) 615-1955
URL	www.bfgtech.com

*Custom Demo: DeathMatch DesertIsle map

AOPEN GEFORCE FX 5500



Go back six months to when the latest graphics cards offered only a glimpse of what is now possible—go back a year, even—and the AOpen GeForce FX 5500 would still be a disappointment.

Just take a look at the card's benchmarking scores, which were some of the lowest scores we've seen in a long time, including posting 5521 3D marks in 3DMark2001 SE, 1120 3D marks in 3DMark03, and a score of 8119 in AquaMark3. In Quake III tests, the card registered 123fps and 50.1fps at resolutions of 1,024 x 768 and 1,600 x 1,200, respectively. To put things in perspective, compare those figures to the ones put up by the Asylum GeForce FX 5200 Ultra. The latter posted scores that were nearly double that of the GeForce FX 5500, including 10303 3D Marks in 3DMark2001 SE, 2005 in 3DMark03, and a score of 11360 in AquaMark3.

How does that transfer to real game play? Poor performance, that's how. Expect the GeForce FX 5500 to work with most DX8.1 games. The chipset supports DX9—it also features such technology as Intellisample HCT and NVIDIA's CineFX engine, as well as nView, NVIDIA Accuview Antialiasing, NVIDIA Lightspeed Memory Architecture (LMAII), and DVC (digital vibrance control)—but don't expect the card to sustain high resolutions. Whereas most of the cards we tested showed at least 23fps during our custom demo test in Unreal Tournament 2004, the GeForce FX 5500 offered only 14.89fps. We had to lower the resolution to 1,024 x 768 just to make the game playable.

Apparently, AOpen did not attempt to make up for such mediocrity through cosmetics or a fancy hardware or software bundle. The company throws in no cables, adapters, or even software. The only thing that makes the card unique is its color (bright purple), and we're guessing that not many users will find that distinction to be worth the card's shortcomings.

To be fair, however, the FX 5500 was the most inexpensive card we purchased ($79 at retail). In addition, it includes all the typical graphics card outputs: VGA, DVI, and S-Video. It also overclocked fairly well. We raised its default core clock speed of 270 and its default memory clock speeds of 400 to the more playable speeds of 350/470, thereby proving once again that the best overclockers can sometimes be the least powerful cards. CPU

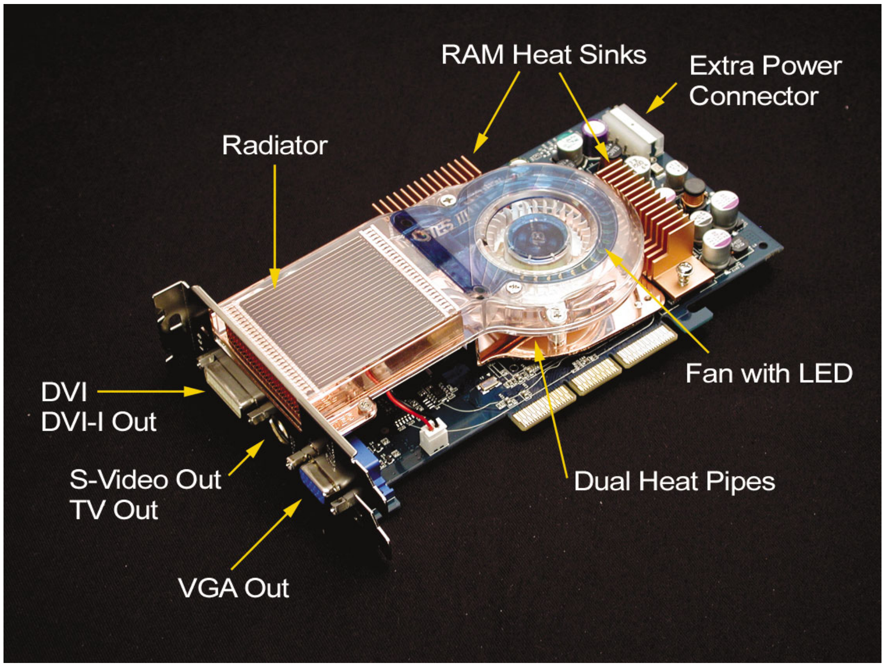
by Eric Melvin Reed

Vital Statistics

Video Card	AOpen GeForce FX 5500
Interface	AGP 8X
Chipset	GeForce FX 5500
RAM	128MB DDR
Core Clock	270MHz
Memory Clock Actual (Effective)	400MHz (800MHz)
Overclocked Maximums (core clock/memory clock in megahertz)	350/470
Max. Resolution	2,048 x 1,536
Refresh Rate at Max. Resolution	60Hz
APIs Supported	DirectX 9.0, OpenGL
Operating Systems	Win95/98SE/Me/ NT4/2000/XP, Linux
3DMark2001 SE	
3D Marks [overclocked]	5521 [6261]
Fill Rate (single texture)	331.1
Fill Rate (multitexture)	743.7
3DMark03	
3D Marks [overclocked]	1120 [1246]
Fill Rate (single texture)	332.4
Fill Rate (multitexture)	697.2
Quake III Arena at 32-bit	
1,024 x 768	123
1,600 x 1,200	50.1
Unreal Tournament 2003 at 32-bit (average fps)	
Anatalus 1,024 x 768	39.7
Anatalus 1,600 x 1,200	16.4
Phobos2 1,024 x 768	46.7
Phobos2 1,600 x 1,200	20
Unreal Tournament 2004 at 32-bit*	
1,600 x 1,200	14.89
AquaMark3 at 32-bit	
Default Test [overclocked]	8119 [8549]
GFX [overclocked]	848 [896]
CPU [overclocked]	9312 [9312]
Halo	
1,600 x 1,200	6.06
1,600 x 1,200 (AA/AF at full)	5.26
Phone	(888) 972-6736
URL	usa.aopen.com

*Custom Demo: DeathMatch DesertIsle map

ABIT SILURO FX 5600 ULTRA OTES



At $195, the ABIT Siluro FX 5600 Ultra OTES is one of the priciest cards in our video card case studies. It's also one of the bulkiest, being loaded with extra features.

Thanks in large part to ABIT's heat transferring OTES (Outside Thermal Exhaust System) technology—which includes two 6mm diameter heatpipes, dual-ball bearing fans with side airflow, extra large copper fins, extra front and back RAM heatsinks, a backside steel fixer for aiding in heat dissipation, and a V.V.E.F. (Virtual Vacuum Exhaust Fan)—the Siluro FX 5600 Ultra OTES exhibited one of the most respectable overclocking performances we've seen in testing midrange cards.

We were able to wind it up from a base of 428MHz clock/825 memory to 475/875. In Quake III tests, the card scored as high as 297fps at 1,024 x 768, and 162.4fps at 1,600 x 1,200. During overclocking, AquaMark3 scores increased from 22544 to 26285. 3DMark 2001 SE and 3DMark03 scores rose from 12961 to 13797 and 3245 to 3690, respectively.

But the OTES certainly wasn't one of the most powerful cards we tested. During Unreal Tournament 2004 play, we encountered significant freezing and jerking at resolutions higher than 1,600 x 1,200 at 32-bit.

The card's list of physical features also includes a red LED fan light and double fastening brackets. In short, the Siluro FX 5600 Ultra OTES is a card for those who delight in flaunting their case's innards.

We should also mention that the package includes oodles of accessories, such as an RCA cable, S-Video extended cable, S-Video-to-RCA cable, S-Video and RCA adapter cable, TV-out or video in/out adapter cable, and DVI-to-D-sub adapter.

Other features include NVIDIA's nView Multidisplay and Intellisample technologies, CineFX shading architecture, DVC (Digital Vibrance Control) 3.0 technology, and DX9 and OpenGL 1.4 support.

Accessories aside, the package is a bit disappointing. The software bundle consists of a couple of demos, WindowBlinds NV edition, and the installation and Siluro software CDs.

If you're into overclocking hulking graphics cards, you'll be interested. If not, you might want to take the extra cash and get a lighter card with a higher base speed, such as the eVGA GeForce FX 5700 Ultra, which failed to show any improvements during our overclocking tests but performed much better than the Siluro OTES at its base speed and costs about $30 less.

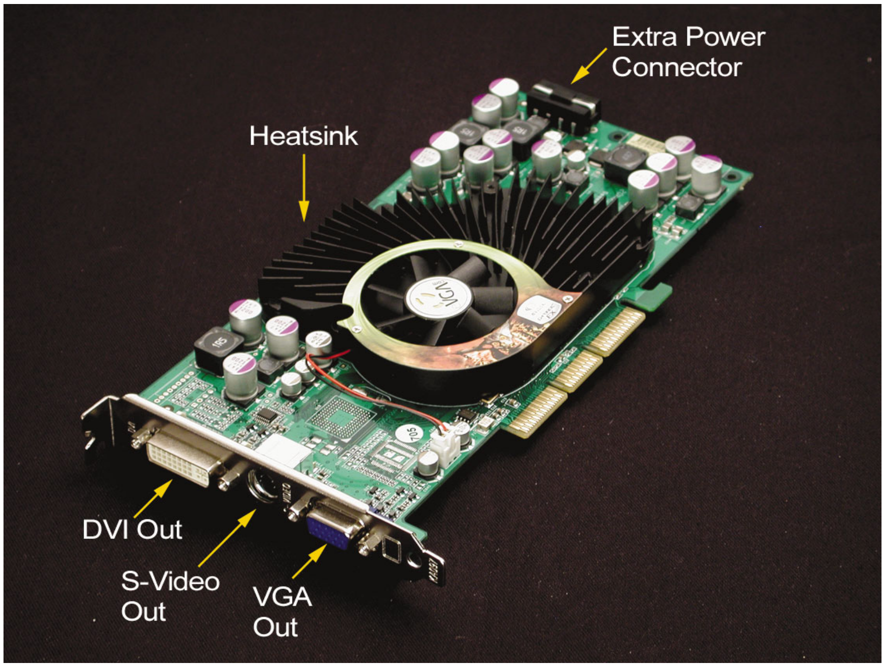
by Eric Melvin Reed

Vital Statistics

Video Card	ABIT Siluro FX 5600 Ultra OTES
Interface	AGP 8X
Chipset	GeForce FX 5600 Ultra
RAM	128MB DDR
Core Clock	400MHz
Memory Clock Actual (Effective)	400MHz (800MHz)
Overclocked Maximums (core clock/memory clock in megahertz)	475/875
Max. Resolution	2,048 x 1,536
Refresh Rate at Max. Resolution	85Hz
APIs Supported	DirectX 9.0, OpenGL 1.4
Operating Systems	Win98/Me/NT/2000/XP
3DMark2001 SE	
3D Marks [overclocked]	12961 [14070]
Fill Rate (single texture)	1171
Fill Rate (multitexture)	1444.5
3DMark03	
3D Marks [overclocked]	3245 [3690]
Fill Rate (single texture)	1115
Fill Rate (multitexture)	1392.4
Quake III Arena at 32-bit	
1,024 x 768	297
1,600 x 1,200	162.4
Unreal Tournament 2003 at 32-bit (average fps)	
Anatalus 1,024 x 768	119.1
Anatalus 1,600 x 1,200	54.1
Phobos2 1,024 x 768	123.5
Phobos2 1,600 x 1,200	57.5
Unreal Tournament 2004 at 32-bit*	
1,600 x 1,200	25.31
AquaMark3 at 32-bit	
Default Test [overclocked]	22544 [26285]
GFX [overclocked]	2564 [3062]
CPU [overclocked]	9291 [9273]
Halo	
1,600 x 1,200	11.22
1,600 x 1,200 (AA/AF at full)	9.86
Phone	(510) 623-0500
URL	www.abit-usa.com

*Custom Demo: DeathMatch DesertIsle map

EVGA E-GEFORCE FX 5700 ULTRA



Talk to some card makers, and you would think overclocking was a sin. Do it and you'll not only negate the warranty, they say, but you'll also overheat the chipset and destroy your PC.

Then again, a little homework is all it takes to learn how to avoid such mistakes. If you're one of those people who actually listen to the vendors and heed their warnings, have a look at the FX 5700 Ultra.

We tested the e-GeForce FX 5700 Ultra from eVGA ($165 retail). At its core clock speed, the card bested most of the NVIDIA cards in our case studies. (It more than edged out a few, such as the NVIDIA GeForce FX 5200 Ultra, unsurprisingly.)

But when it came to overclocking, this set of chips choked harder than a certain Boston baseball team in October. Performance decreased by as much as 24% in 3DMark2001 SE and 3DMark-03. And in AquaMark3 tests, speed decreased by more than one-third of its stock performance.

However, there are a few features on the card that augment its value. Two such features are NVIDIA's Intellisample HCT (high-resolution compression technology) antialiasing and NVIDIA's CineFX 2.0 engine, the latter of which is designed for high-level programming languages such as Cg and includes OpenGL and DirectX environment features support. The card also supports a high resolution and refresh rates at 32-bit color: 2,048 x 1,536 at 85Hz.

Our "limited edition" test unit featured the next generation of DDR memory, DDR2. It also came with an S-Video cable and an entertainment software bundle that included, among other things, the full version of Tom Clancy's Ghost Recon and NVIDIA's NVDVD 2.0. Even though the sticker on the box says, "Recommended by id software for Doom 3," there wasn't a full-version coupon or demo inside. (ATI's Half-Life 2 giveaway has us a bit spoiled.)

If the graphics industry has yet to convince you that overclocking is an instrument of the devil, you might want to give some serious thought to a card other than this one. You may be able to find a less expensive, earlier generation card in the same family that when overclocked can outrun the FX 5700 Ultra. (Of course, that is not often the case. In our tests, the FX 5700 Ultra easily outperformed the FX 5600 Ultra, even when the 5600 Ultra was overclocked to its maximum.) CPU

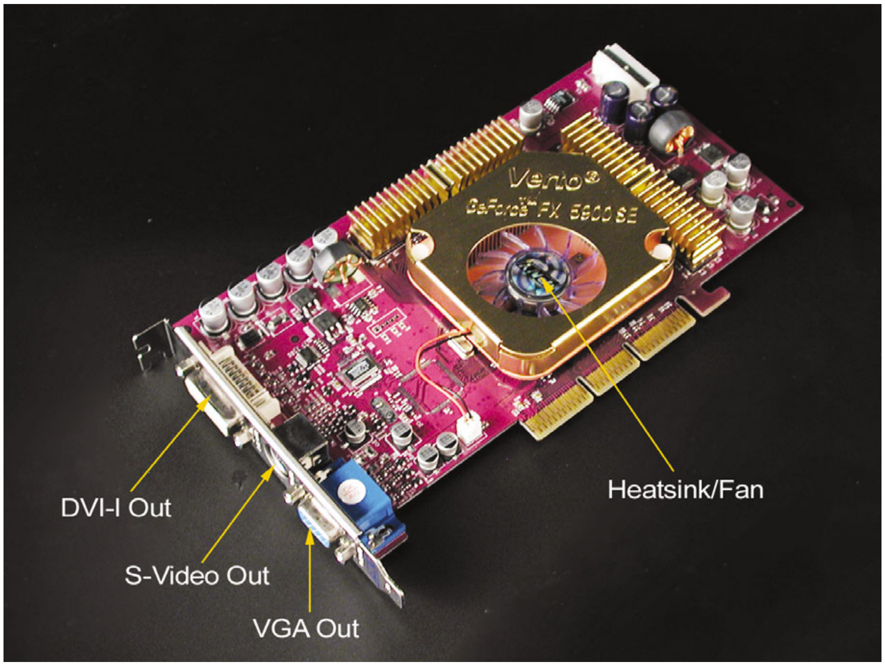
by Eric Melvin Reed

Vital Statistics

Video Card	eVGA e-GeForce FX 5700 Ultra
Interface	AGP 8X
Chipset	GeForce FX 5700 Ultra
RAM	128MB DDR
Core Clock	475MHz
Memory Clock Actual (Effective)	450MHz (900MHz)
Overclocked Maximums (core clock/memory clock in megahertz)	500/920
Max. Resolution	2,048 x 1,536 (32-bit)
Refresh Rate at Max. Resolution	85Hz
APIs Supported	DirectX 9.0, OpenGL
Operating Systems	Win98/Me/NT4/ 2000/XP
3DMark2001 SE	
3D Marks	15689 [3784]
Fill Rate (single texture)	1236.3
Fill Rate (multitexture)	1640.8
3DMark03	
3D Marks	3910 [941]
Fill Rate (single texture)	1163
Fill Rate (multitexture)	1573.8
Quake III Arena at 32-bit	
1,024 x 768	304.5
1,600 x 1,200	173.9
Unreal Tournament 2003 at 32-bit (average fps)	
Anatalus 1,024 x 768	130.7
Anatalus 1,600 x 1,200	58.3
Phobos2 1,024 x 768	138.8
Phobos2 1,600 x 1,200	64.4
Unreal Tournament 2004 at 32-bit*	
1,600 x 1,200	14.98
AquaMark3 at 32-bit	
Default Test	29462 [10458]
GFX	3503 [1106]
CPU	9266 [9349]
Halo	
1,600 x 1,200	15.34
1,600 x 1,200 (AA/AF at full)	13.19
Phone	(888) 881-3842
URL	www.evga.com

*Custom Demo: DeathMatch DesertIsle map

PNY GEFORCE FX 5900 SE



By now, you can probably list NVIDIA's features by rote: CineFX 2.0 engine, UltraShadow and Intellisample HCT technologies, Digital Vibrance Control 2.0, nView, MPEG-2 decoder, TV encoder, and DX9 and OpenGL 1.5 support. The PNY GeForce FX 5900 SE has all of those. What makes it unique is its enormous overclocking potential.

With a 390MHz core clock speed, a 350MHz memory clock speed (actual), and 256-bit memory interface, the card sliced through our barricade of tests. For example, its 3DMark2001 SE score of 16754 trounced the 13,611 posted by the Sapphire ATI Radeon 9800 SE. So, too, do the card's Unreal Tournament 2003 scores. At a resolution of 1,024 x 768, the card hammered out average scores of 181.2fps in the Anatalus level, and 185.9fps in the Phobos2 level. In the same tests, the 9800 SE scored 88.1 and 110.7. In AquaMark 3 default tests the card scored 37205.

At a resolution of 1,600 x 1,200, the card continued to outperform the 9800 SE, scoring an average of 84.5fps in the Anatalus level and 96.9fps in the Phobos2 level. (The 9800 SE grated out an average of just 37.1fps and 51fps.)

We then overclocked the card to 490MHz clock (up from 390MHz clock) and 400MHz memory (from 350MHz), at which point the card's 3DMark2001 SE and 3DMark03 scores jumped to 17794 and 6131. AquaMark 3 scores in the default test rose to 44990.

The card isn't bad looking, either. Apparently, manufacturers have decided to all but abandon the color green and replace it with blue and purple. Our card was purple, but it is easy to see why PNY would choose such a saccharine color. The lavender tinge actually compliments the FX 5900 SE's multiple gold-colored heat sinks.

The back of the card contains an extra power connector. In the front, it supports VGA, S-Video, and DVI out connections.

To show that it isn't stingy when it comes to accessories, PNY throws a DVI-I-to-VGA adapter, S-Video cable, and Y-adapter power cable into the box. Add to that a driver CD with Verto 3D World Desktop software and NVIDIA NVDVD, and it's hard to imagine anyone finding a better card for the equivalent price of $200. PNY also backs the card with a lifetime replacement warranty, almost to demonstrate its confidence in the FX 5900 SE.

Overall, the FX 5900 SE offers enough speed and game play performance potential to meet the needs of any gamer for years to come.

by Eric Melvin Reed

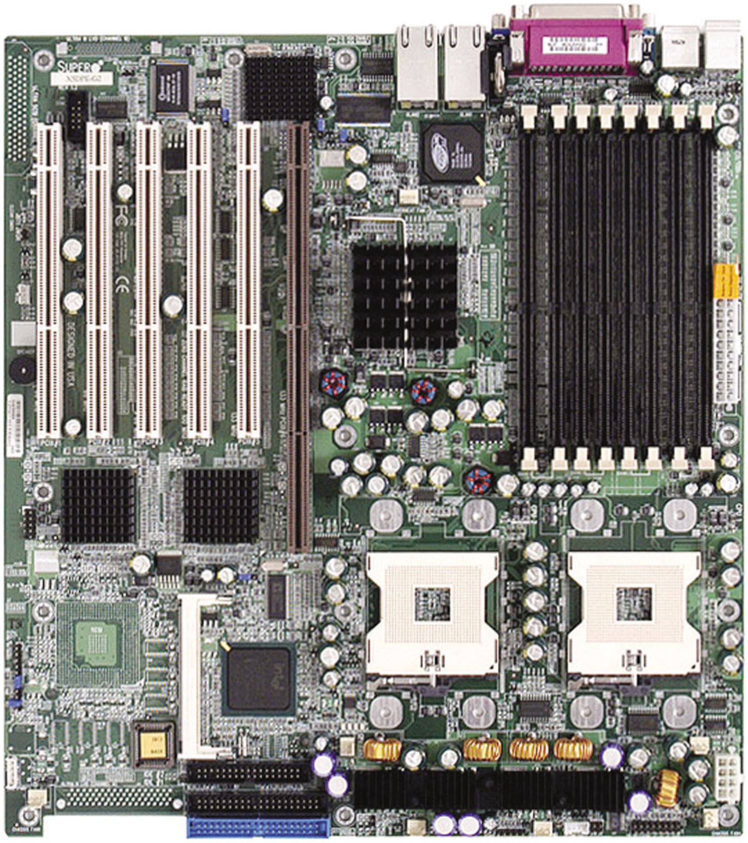
Vital Statistics

Video Card	PNY GeForce FX 5900 SE
Interface	AGP 8X
Chipset	GeForce FX 5900 SE
RAM	128MB DDR
Core Clock	390MHz
Memory Clock Actual (Effective)	350MHz (700MHz)
Overclocked Maximums (core clock/memory clock in megahertz)	490/400
Max. Resolution	2,048 x 1,536
Refresh Rate at Max. Resolution	85Hz
APIs Supported	DirectX 9.0, OpenGL 1.5
Operating Systems	Win95 OSR2/98SE/Me/NT4/2000/XP
3DMark2001 SE	
3D Marks [overclocked]	16754 [17794]
Fill Rate (single texture)	1434.5
Fill Rate (multitexture)	2858.8
3DMark03	
3D Marks [overclocked]	5179 [6131]
Fill Rate (single texture)	1273.8
Fill Rate (multitexture)	2765.8
Quake III Arena at 32-bit	
1,024 x 768	311.7
1,600 x 1,200	224.1
Unreal Tournament 2003 at 32-bit (average fps)	
Anatalus 1,024 x 768	181.2
Anatalus 1,600 x 1,200	84.5
Phobos2 1,024 x 768	185.9
Phobos2 1,600 x 1,200	96.9
Unreal Tournament 2004 at 32-bit*	
1,600 x 1,200	26.1
AquaMark3 at 32-bit	
Default Test [overclocked]	37205 [44990]
GFX [overclocked]	4658 [5951]
CPU [overclocked]	9233 [9211]
Halo	
1,600 x 1,200	21.7
1,600 x 1,200 (AA/AF at full)	17.3
Phone	(973) 515-9700
URL	www.pny.com

*Custom Demo: DeathMatch DesertIsle map

OVERCLOCKING DUAL-CPU SYSTEMS

Double Your Overclocking Madness


The SuperMicro X5DPE-G2 board is a dual-CPU Xeon board designed for server duty; the board features some, albeit few, overclocking options.

Those who enjoy pushing their rigs to the absolute performance limits take to overclocking like ducks take to water. The Internet is full of Web sites and discussion forums dedicated to dispensing advice for those looking to overclock their machines.

The lion's share of the overclocking talk is primarily dedicated to discussions about PCs and CPUs marketed to gamers and performance hobbyists. These machines are usually single-CPU rigs with overclock-friendly motherboards that make overclocking as easy as changing a few settings in the system BIOS.

But how about those who want to double the fun by overclocking a dual-CPU rig? With the advent of OSes such as Windows XP, which take full advantage of a dual-CPU machine's capabilities, the temptation to overclock may be too hard to resist for those of you who want the ultimate in performance. After all, two is better than one, right?

Read on to learn more about the ins and outs of overclocking a dual-CPU PC. As you'll soon discover, the task is not as easy as it seems.

The Problem With Two

We encountered quite a challenge in acquiring a dual-CPU machine that was overclock-friendly. We spoke with a technical manager at one of the big PC makers, who told us that most dual-CPU motherboards are manufactured and marketed with the workstation and server markets in mind. Computation-heavy tasks like video editing, engineering design, and data and application servers benefit greatly from the presence of dual CPUs, as long as the host OS is able to take advantage.

Unfortunately for overclockers, the folks who put those machines to use are not too interested in overclocking. Their main focus is using the machine's capabilities to get work done.

So, workstation and server users value stability and bandwidth. Many of the server and workstation boards are optimized to maximize PCI bandwidth, and their BIOSes incorporate features for monitoring system conditions and ensuring stability above all else. Because overclocking can result in system instability, especially in cases where the only available option for overclocking is the FSB speed, workstation and server users don't place a premium on overclocking options.

The CPU's frequency is tied to the frequency of the FSB by a number called the CPU multiplier. For example, in a system with a 100MHz FSB, a CPU multiplier of 8X results in a CPU that runs at 800MHz. So, the situation seems fairly straightforward: Increase the FSB speed (if your motherboard's BIOS allows you) and enjoy a higher CPU speed. But the reason that relying on the FSB frequency to overclock a CPU can cause system instability is that the CPU clock speed is not the only component tied to the speed of the FSB. The other buses in your system, such as the PCI and AGP buses, will also experience a bump up in speed when you increase the FSB speed. So, the various components connected to these buses could become unstable at these higher speeds.

A reason why the CPU multiplier is usually not available as an option for easy overclocking is the fact that most CPUs from both Intel and AMD sold today have their multipliers locked. The reason for this is that back in the early days (before the Pentium II arrived) unscrupulous resellers were overclocking lower speed chips and selling them at the price of higher-speed, more expensive chips. The outcry from consumers who got taken by this ruse caused both AMD and Intel to lock down the CPU multipliers in their chips to prevent easy overclocking.

Dual-CPU Overclocking Successes

A survey of many of the overclocking sites around the Web revealed there is scant evidence of success overclocking dual-CPU boards, although we found a few examples of overclocker-friendly dual-CPU boards.

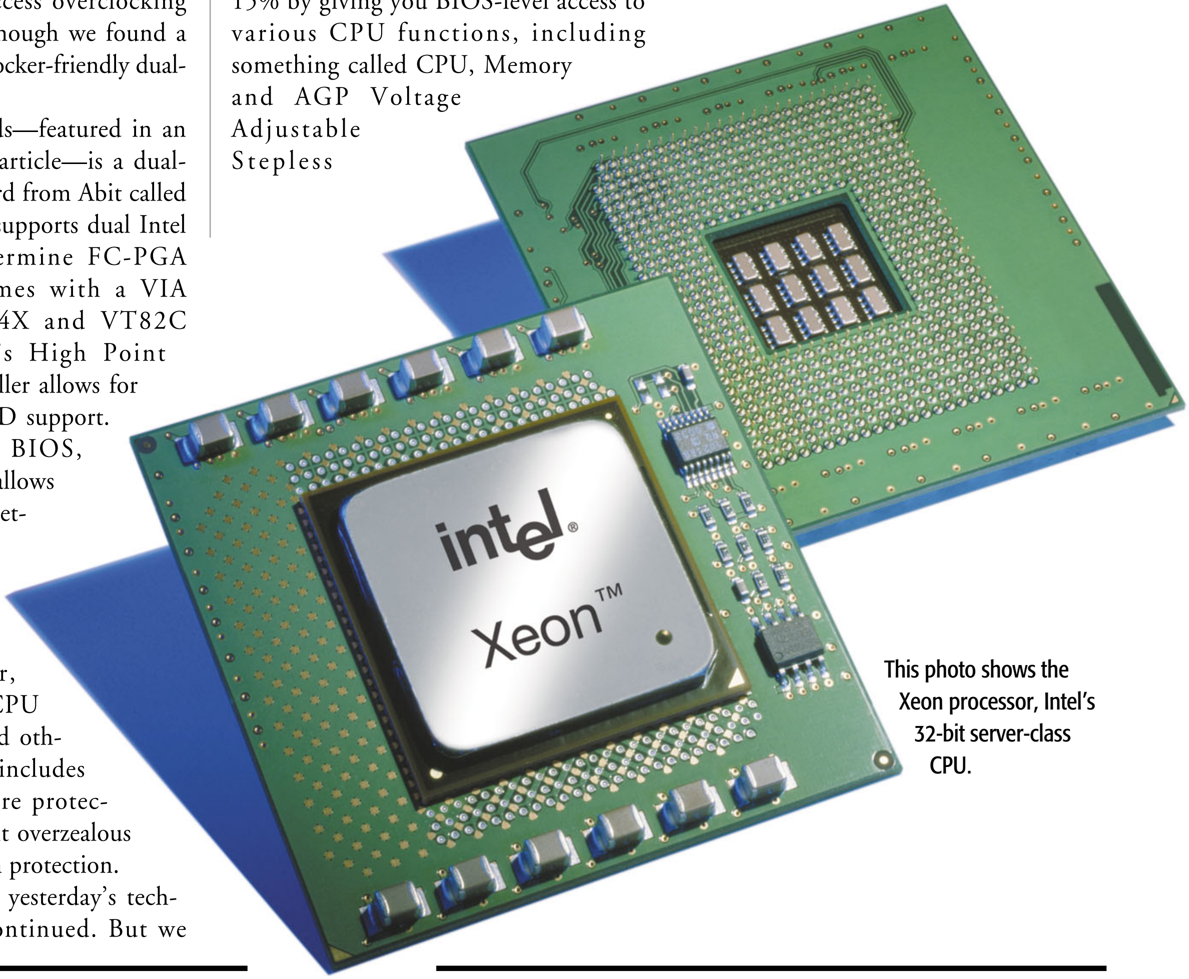
One of these boards—featured in an Overclockers Online article—is a dual-CPU Pentium III board from Abit called the VP6. This board supports dual Intel Pentium III Coppermine FC-PGA 370 CPUs and comes with a VIA chipset (VT82C694X and VT82C 686B). The board's High Point HPT370 IDE Controller allows for UDMA 100 and RAID support. The VP6's system BIOS, called SoftMenu III, allows for tweaking of CPU settings via the system BIOS, including CPU FSB speed, FSB:AGP:PCI ratio, CPU multiplier, CPU core voltage, CPU FSB/DRAM ratio, and others. The BIOS even includes CPU over-temperature protection, so if you get a bit overzealous you have some built-in protection.

The VP6, which is yesterday's technology, is now discontinued. But we moved up the food chain just a tad and found a dual-Xeon workstation motherboard from Asus called the PC-DL Deluxe that is very overclocker-friendly. Here's the tale of the tape on the PC-DL Deluxe:

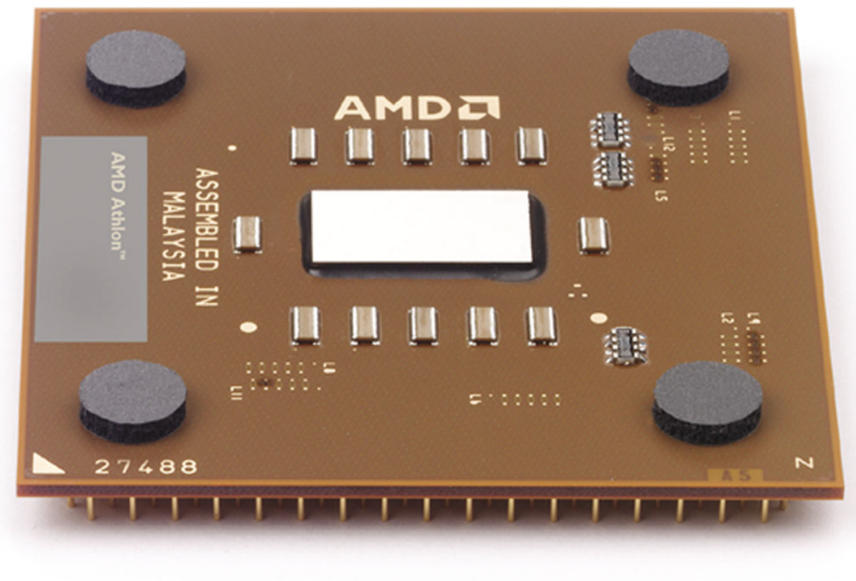
- Dual-Xeon 3.06GHz processors
- Maximum of 4GB of DDR 333 memory
- Intel 875P chipset with 533MHz FSB, Dual DDR 333 memory, and Intel Hyper-Threading technology
- AGP8X
- Promise SATA controller with RAID 0, 1, and 10 and a maximum of two UltraATA 133 ports and two SATA ports
- Eight USB 2.0 ports and FireWire interface
- Intel Gigabit Ethernet LAN controller
- AI BIOS with AI Overclocking

The AI BIOS' AI Overclocking feature allows for overclocking of up to 15% by giving you BIOS-level access to various CPU functions, including something called CPU, Memory and AGP Voltage Adjustable Stepless Frequency Selection, which allows you to step up the FSB frequency from 100MHz to 300MHz in 1MHz increments. Other features include an adjustable FSB:DDR ratio and fixed AGP and PCI frequencies, which should provide you with needed stability on those buses even as you ramp up the CPU speed. Keeping the AGP and PCI frequencies fixed even as you overclock other components should help with overall system stability.

But it's important to keep one thing in mind about the Intel Xeon: The CPU multiplier is upward locked but downward unlocked. This means that when you overclock with this board, you can lower the Xeon's multiplier, but then you must compensate for that by increasing the FSB speed accordingly. Here's an example: On a board with a 133MHz quad-pumped (hence the 533MHz overall bus speed) FSB, a 3.06GHz Xeon has



This photo shows the Xeon processor, Intel's 32-bit server-class CPU.



The Athlon MP processor is AMD's server-class CPU, used with various dual-CPU boards that use AMD's 760 MPX dual-CPU chipset.

a multiplier of 23X. To ramp up the CPU to 3.5GHz, you could lower the multipler to 20X and at the same time increase the FSB speed to 175MHz. By the same token, you could leave the multiplier alone and simply crank up the FSB to 152MHz and achieve the same effect.

SuperMicro's X5DPE-G2 board is another example of a dual-CPU (Xeon) board on which you can tweak the settings via the system BIOS. Here's the breakdown on this board:

- Dual Intel Xeon CPUs up to 3.2GHz
- 533MHz or 400MHz FSB
- Up to 16GB of DDR 266 or DDR 200 registered ECC SDRAM 72-bit, 184-pin gold-plated DIMMs.
- Intel E7501 chipset
- Gigabit Ethernet
- Integrated ATI RageXL 8MB PCI Graphic Controller
- Rackmount Tower/4U recommended chassis

This board's frequency settings can be tweaked via its system BIOS under the Advanced Processor options. Here, you can specify the processor's internal multiplier, from 8X to 24X. Also, the board allows you to change the frequency of PCI slots 1 through 3 and PCI slots 4, 5, and 6. But the problem here is that with Xeon CPUs, you will only be able to adjust the multiplier downward. And the only way we saw that you could adjust the FSB speed is via jumpers on the board. Using these jumpers, you have the choice of three settings: Auto, 533MHz, and 400MHz. So, flexibility here is rather limited.

You might wonder why we are discussing a board that is clearly an enterprise-class server system board. Well, we want to illustrate the point that some motherboard manufacturers do include some overclocking flexibility, even on boards designed for the corporate server market. But as the discussion above suggests, those options, at least on this particular board, are rather limited.

How about AMD? Well, we couldn't find any boards that use AMD Opteron CPUs with overclocker-friendly features. But we found a Gigabyte board (the GA-7DPXDW) that uses AMD's 760 MPX dual-CPU chipset and has some overclocker-friendly features. This board includes:

- Support for dual Athlon MP processors
- 200/266MHz FSB
- AMD-760 MPX chipset
- Up to 4GB of registered PC1600/PC2100 DDR modules
- Integrated video controller
- Supports RAID 0, 1, and 0+1 via the Promise PDC 20267 RAID controller

This board's BIOS, even though it doesn't let you tweak settings such as voltages or the CPU multiplier, does give you the option of ramping up the FSB speed, so you have some overclocking flexibility. According to the board's manual, you can set the FSB speed from 133MHz (the default) all the way up to 149MHz. As you ramp up the FSB, the PCI bus also increases, so there is not a setting that allows for a fixed PCI bus speed.

The Skinny On Overclocking "Dualies"

Dual-CPU boards present some significant advantages if you are running specific software applications that are able to take advantage of a dual-CPU configuration. One common thread we saw in many discussions about dual CPUs in overclocker forums is that unless you are using applications such as video-editing software that require intensive CPU work, you will not get the big payoff you might expect out of a dual-CPU configuration. Many games, for example, are not written to take advantage of dual-CPU setups.

If you still want to find an overclockable dual-CPU board that you can tweak to your heart's content, we recommend that you shop carefully. Many of the boards we looked at had minimal overclocker-friendly settings, and many required using the jumpers on the board itself to make any adjustments. Asus's PC-DL Deluxe is an exception here and features more overclocking adjustments via its BIOS than any other new board we looked at.

One thing you can count on for sure is that manufacturers are not going to stand still. If hardcore performance enthusiasts and gamers start demanding more overclocking options for dual-CPU boards, manufacturers will be more than happy to oblige. So keep your eyes and ears open because that dual-CPU board of your dreams may soon be a reality. CPU

by Sixto Ortiz Jr.

RACE FOR THE GOLD

AMD vs. Intel For The Performance Crown

Both AMD and Intel have launched a barrage of new processors since our first *PC Modder* issue hit the street, so we've selected new contenders from each camp and overclocked them into oblivion (see Case Studies). But even as we squeezed every last 3Dmark out of these processors, our thoughts turned to the CPU giants' champions: the 3.4GHz P4 Extreme Edition and the Athlon 64 FX-53. After comparing each processor/mobo combo to its own siblings in the previous section, it's only fitting that we give the top Intel and AMD processors a chance to duke it out.

Until now, we haven't broken free of the standard cooling system. We love exotic cooling devices as much as the next modder, but we wanted to give you an idea of each processor/mobo combo's overclocking potential under normal conditions, so our Case Studies articles stuck to a traditional heatsink/fan setup. (Sort of; the test systems did have fan cooling. We concede that our gigantic, all-copper Thermalright SLK-948U heatsink and 119CFM spewing, 92mm pcToys Tornado fan don't fit neatly under "normal's" umbrella).

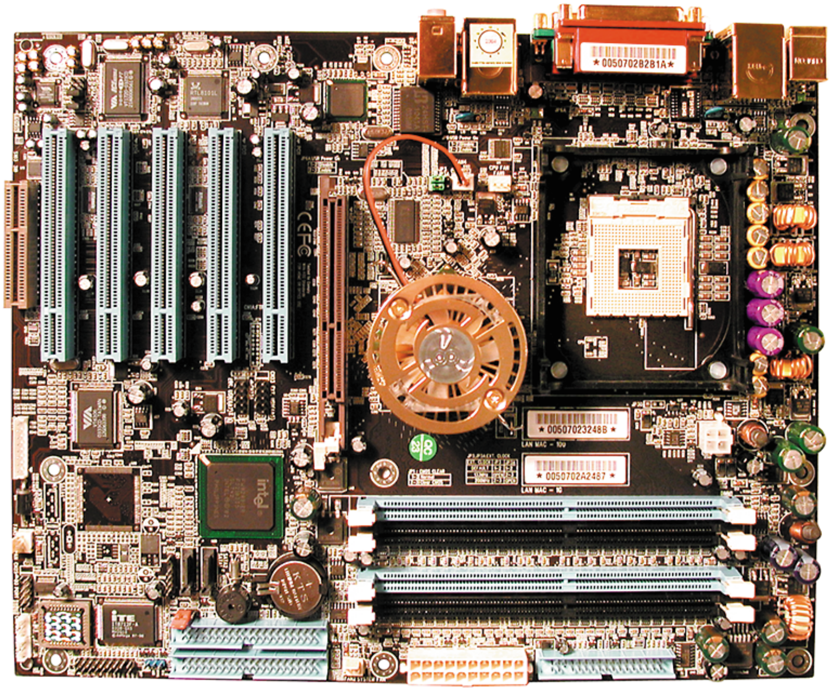
We wanted our systems to battle each other instead of heat. We considered a watercooling system, but watercooling simply can't compete with a phase-change system's super-cold touch. We settled on the nVentive Mach II, a powerful system that sits underneath your computer's chassis. The Mach II isn't particularly handsome, but it sports a temperature-gauge LCD, so we're not complaining. Unfortunately, nVentive (formerly Prometia) recently threw in the towel, making the Asetek Vapochill the reigning cooling champ. Luckily, we already had a Mach II, courtesy of CINDI (Computer In Need Of Drastic Improvement; our beloved "Swappin' Parts" machine from *CPU* issues gone by).

As with the Case Studies articles, we tried to stock our competing systems with identical components. We transferred most of our Case Studies test system components to the new beast, including the power supply, hard drive, and video card. We weren't able to use identical memory DIMMS, as our 940-pin FX-53 requires server-friendly registered memory.

We used two benchmarks to test our systems' mettle: Futuremark 3Dmark03 and PCMark04. Although 3Dmark03's benchmarking methods garnered plenty of controversy when it arrived, Futuremark released a patch that removed the most egregious problems. In fact, the new version of 3Dmark03 renders scores based on the old version obsolete. 3Dmark03 is a synthetic benchmark that focuses on 3D game play performance. PCMark04 tests overall system performance and offers several component-specific scores and an overall score.

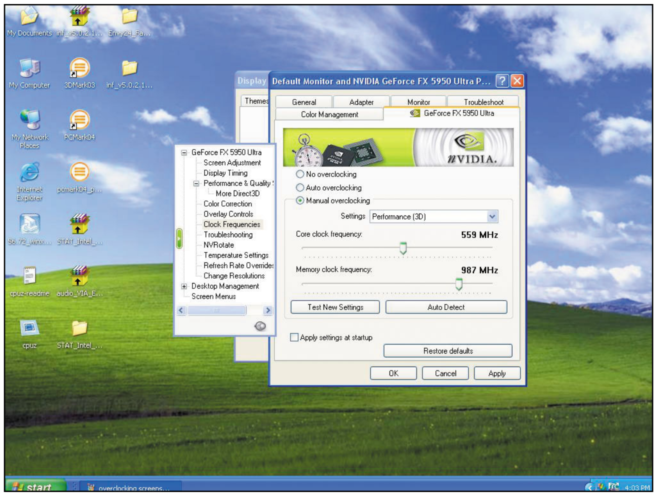
Once we pushed our processors as far as they could go, we squeezed every last drop of performance from our PCs by tweaking other component settings, such as memory and video card voltages and frequencies. By default, our Gainward PowerPack! Ultra/1800 XP Golden Sample GeForce FX 5950 Ultra's GeForce Properties (in Display Properties) didn't include overclocking features, so we downloaded and installed the CoolBits registry key, which unlocks NVIDIA's CoolBits overclocking utility.

Thanks to the CoolBits tweak, the GeForce Properties' GeForce tab displayed a new section: Clock



Chaintech's 9CJS Zenith motherboard comes with a number of features, but it's the board's performance and stability that prompted us to use it in this article.

Frequencies. We clicked the Manual radio button, selected Performance 3D from the Settings drop-down menu, and then used the Core Clock Frequency and Memory Clock Frequency slider bars to adjust the frequencies. The section has a variety of features, including a Restore Defaults button and an Apply Settings At Startup checkbox. If you check this box, the system will retain the overclocked settings indefinitely. Otherwise, your video card will return to default settings when your system reboots. Until you reach your video card's maximum stable settings, you'll probably want to avoid the checkbox.



○ No overclocking
○ Auto overclocking
● Manual overclocking
Settings: Performance (3D)
Core clock frequency: 559 MHz
Memory clock frequency: 987 MHz
☐ Apply settings at startup

Thanks to CoolBits, our NVIDIA GeForce 5950-based video card's Display Properties let us adjust the Core Clock Frequency and Memory Clock Frequency settings.

Aside from the motherboard and CPU, our systems stand on a level playing field. Who will prove to be the overclocking champ will depend on the systems themselves.

AMD

Sure, sure, Intel has a super-fast, super-expensive processor. But AMD has a few speed record/budget breakers of its own, the fastest of which resides in the heart of our overclocked system: the 2.4GHz AMD Athlon 64 FX-53.

Meet the hardware. The 940-pin FX-53 marks the end of the 940-pin FX chip, as AMD recently switched to the 939-pin model. AMD launched several new 939-pin Athlon 64's just before we went to press and also released a 939-pin version of the FX-53. The switch means that users who already have a 940-pin FX-51 or FX-53 will need to buy a new motherboard when they upgrade, but it also means that users won't need to invest in the expensive registered memory that 940-pin processors require. That change opens up the wide market of nonregistered memory to performance enthusiasts. As with the FX-51, the FX-53 features the 0.13-micron design and has an integrated memory controller, a 128KB L1 cache (a 64KB instruction cache and a 64KB data cache), and a 1024KB L2 cache.

We chose 2GB of Corsair registered DDR memory and plugged it into the ASUS SK8V, which posted the best scores in our FX-51 Case Studies articles. We loved the SK8V's performance, but we also liked its features. Thanks to a VIA VT6307 FireWire controller, the board includes two internal FireWire headers (and a D-bracket that sports a single FireWire port). The FireWire controller complements the VIA K8T800 northbridge and VT8237 southbridge. If you're building a powerful system on a not-so-powerful budget, you may want to forgo a sound card in favor of the board's integrated six-channel setup.

ASUS skipped the CNR that still occasionally appears on boards but added a similar slot that supports an optional ASUS WiFi@Home card. The card, which goes for about $25, connects to an external antenna and supports 802.11b connectivity. A 3COM 3C940 Gigabit LAN controller supports

AMD Athlon 64 FX-53 (SledgeHammer)
ASUS SK8V

	Processor Speed	FSB	Multiplier	CPU Voltage	Processor Temp	Case Temp	AGP Voltage	RAM Voltage
Stock Performance	2.4GHz	200MHz	12	1.568V	-38	29	1.5V	Auto
Overclocked Performance	2.8GHz	200MHz	14	1.65V	-31	29.4	1.7V	Auto

	Memory Timings	Video Card Core/Memory	3Dmark03	PCMark04	PCMark04 CPU	PCMark04 Memory	PCMark04 Graphics	PCMark04 HDD
Stock Performance	2.5-3-3-7	475/950	6302	4787	4468	4859	5288	4766
Overclocked Performance	2.5-3-3-7	500/975	6681	5433	5144	5333	5467	4774

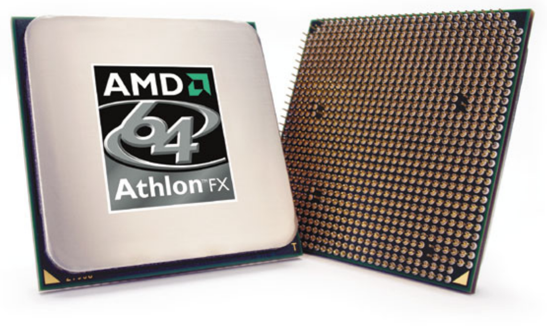
the I/O riser's single Ethernet port. The board also sports three IDE ports and two SATA ports. We like the board's four dual-channel memory slots, which support up to 8GB of PC3200 registered DDR RAM. We took advantage of the dual-channel architecture by using identical 1GB DIMMs.

Before we built our test system, we put the FX-53 and SK8V in our Case Studies test system to see how the system performed under normal conditions. The PC posted excellent scores in 3Dmark03 and PCMark04 (6307 and 4782, respectively). The system didn't respond well to higher frequencies until we upped the voltage, which breathed new life into our test PC. The fan-cooled system posted max scores of 6370 in 3Dmark03 and 5130 in PCMark04, with a clock speed of 2.58GHz and a CPU voltage of 1.7V. Not bad, but not the kind of raging overclock we expect to see when we fire up our Mach II-cooled system.

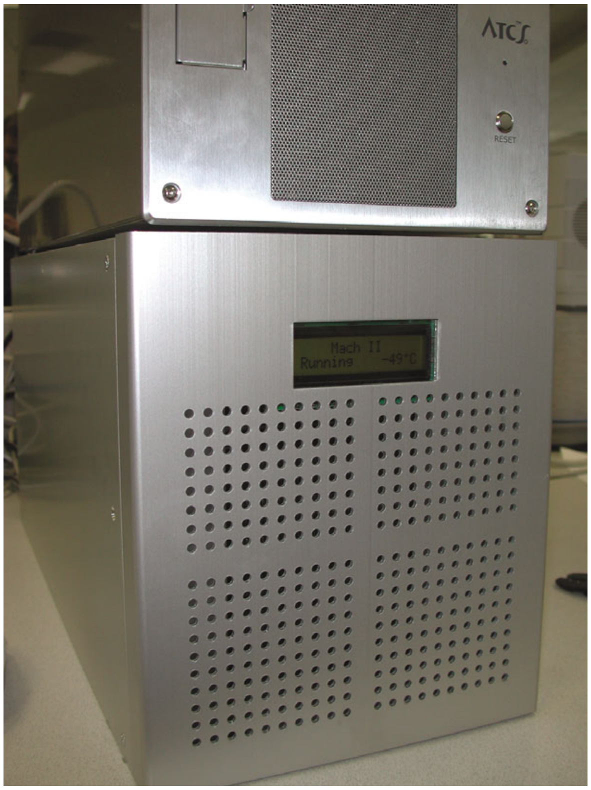
Once we finished our fan-cooled system benchmarks, we gutted our Case Studies test system and used its components to build an almost identical (but oh-so-much-cooler) test PC. We assembled the Prometia AMD 64 EasyMod Kit, attached the Mach II phase-change system to our FX-53, powered on our raging system, and—the computer rebooted before it entered Windows. As it turned out, the Mach II wasn't playing nice with our system. We updated its firmware (version 821) and then booted into Windows without trouble.

Overclocking. Although the SK8V's BIOS has several neat features (such as Q-Fan, which lowers fan speeds when the system is idle), we didn't enable any of the unnecessary perks. We did enjoy C.P.R. (CPU Parameter Recall), an automatic feature that resets the BIOS to its default settings whenever the system hangs. Thanks to C.P.R., we didn't have to manually clear the CMOS at all. We disabled the memory's ECC feature, which would have reigned in our system's raw speed.

We installed the latest BIOS version (ASUS Version 1002), which offers a frequency range of 200MHz to 300MHz, an AGP voltage range of 1.5V to 1.7V, and a DRAM voltage range of 2.5V to 2.8V. The BIOS also included a CPU voltage range of 1.5V to 1.7V. The ASUS SK8N let us push the CPU voltage as high as 1.75V when we overclocked the Athlon 64 FX-51, but the board's benchmark scores couldn't top our SK8V. As it turned out, our system didn't need the extra voltage: it never booted with a voltage higher than 1.65V anyway.



The new AMD Athlon FX-53 was the heart of our experiment, but would it be able to seriously outperform Intel's lightning-fast Pentium 4 Extreme Edition?



Our lab techs found several creative uses for the Prometia Mach II's configurable text display, but we stuck to the default temperature readout while overclocking.

Before we unleashed our FX-53 system, we ran our two benchmarks at default settings (2.4GHz clock speed, 12X multiplier, and CPU voltage of 1.5V). As we expected, our Mach II-cooled system's 3Dmark03 score of 6302 approached the fan-cooled version's top overclocked score of 6370. We weren't surprised to see that of the four PCMark04 component tests (which determine the overall PCMark04 score), the Graphics score took top honors with a score of 5288. We love the Gainward NVIDIA GeForce FX 5950 Ultra's raw power. The CPU, memory, and hard drive posted 4468, 4859, and 4766, respectively, and the system posted a solid PCMark04 score of 4787. Our Mach II's LCD displayed a chilly -38 degrees Celsius, and our Digital Doc 5 displayed a chassis temperature of 29 C.

With solid benchmark scores and subzero CPU temperatures in hand, we decided to turn up the volume. We knew our Mach II-cooled system could probably handle the fan-cooled system's max clock speed (2.5GHz), so we jumped straight to a 220MHz frequency (2.64GHz clock speed) and rebooted the PC. Our test PC completed 3Dmark03, posting a respectable 6393 (already topping the fan-cooled system's max score), but it wasn't stable enough to complete PCMark04. Unfazed, we upped the frequency to

230MHz and the voltage to 1.65V, at which point the system promptly crashed, refusing to load Windows.

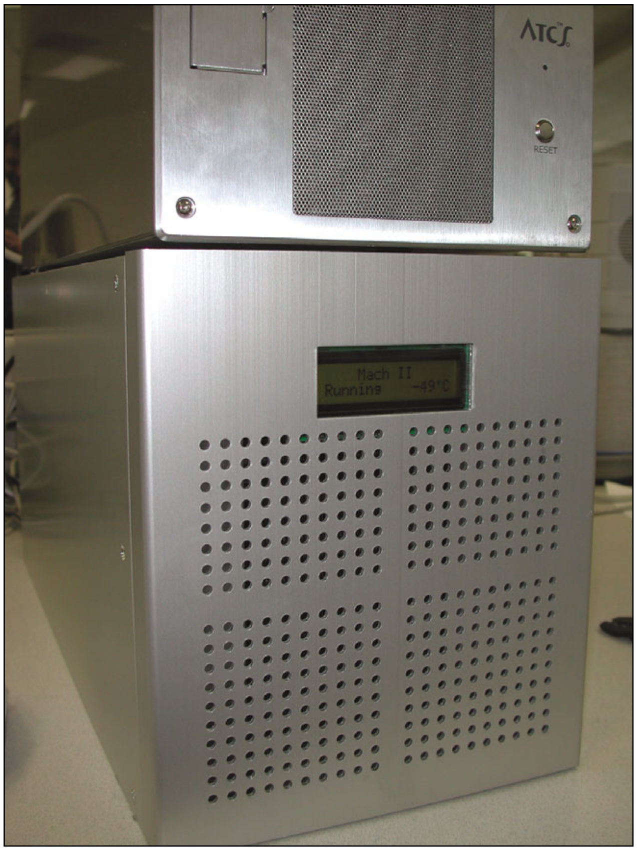
Instead of pushing the CPU voltage to its max, we changed tack, lowering the frequency back to 200MHz but raising the multiplier from 12X to 14X (a whopping 2.8GHz clock speed). We lowered the CPU voltage to a reasonably safe 1.6V and restarted the system. This time, our test PC booted into Windows without any trouble and completed both benchmarks. That said, the system posted a disappointing 6398 3Dmark03 score, only five points higher than its last 3Dmark score.

As it turned out, the system just needed a little extra juice. We raised the CPU voltage to 1.65V and the AGP voltage to 1.7V. We also raised the video card's core to 500MHz (from 475MHz) and the card's memory from 950MHz to 975MHz. Thanks to the extra tweaks, our PC posted 6681 in 3Dmark03 and 5144 in PCMark04; the test PC's max scores. We booted into Windows as high as 2.87GHz, but the system bailed whenever we started 3Dmark03.

Analysis. We almost freaked out when we thought that our super-cold, near $1,000 phase-change unit couldn't push the FX-53's performance any farther than a heatsink/fan combo, but we calmed down when we managed to get the system running stable at higher clock speeds. Our Mach II-cooled system's max 3Dmark score pounded the fan-cooled system's max score by 311 points, but posted only a tiny 14-point PCMark04 improvement over the lesser system's max score. Even so, we were impressed by the FX-53's performance overall: it posted a 379-point 3Dmark03 increase and posted a 646-point PCMark04 increase over its default scores. But is the supercooled processor powerful enough beat out one of Intel's champs?

Intel

No matter how badly AMD would like it to be otherwise, we're not living in a 64-bit world. Sure, the Athlon 64 FX-53 delivers good 32-bit performance, but without a 64-bit OS, we can't take advantage of those mouth watering 64-bit extensions. The 2MB of L3 cache on the 3.4GHz Pentium 4 Extreme Edition, however, doesn't require any specific OS or application support. Can Intel's testament to extreme users overpower AMD's muscular 64-bit processor?



It may not be pretty, but the Prometia Mach II keeps our system at sub-zero temperatures, even when we overclocked our top-of-the-line CPU's.

Meet the hardware. Intel's 3.4GHz Pentium 4 Extreme Edition is the company's flagship processor. The Extreme Edition uses Intel's older Northwood core rather than its new Prescott core, but

Intel 3.4GHz Pentium 4 Extreme Edition

Chaintech 9CJS Zenith

	Processor Speed	FSB	Multiplier	CPU Voltage	Processor Temp	Case Temp	AGP Voltage	RAM Voltage
Stock Performance	3.4GHz	200MHz	17	1.5V	-39	27.1	Default	Default
Overclocked Performance	3.77GHz	219MHz	17	1.65V	-32	28.4	Default	Default

	Memory Timings	VideO Card Core/Memory	3Dmark03	PCMark04	PCMark04 CPU	PCMark04 Memory	PCMark04 Graphics	PCMark04 HDD
Stock Performance	2.5/3/3/8	300/950	6750	5700	5330	5496	5706	4373
Overclocked Performance	2.5/3/3/8	300/950	6884	6095	5817	6023	5720	4347

that's not necessarily a bad thing as Prescott includes a few changes that negatively impact performance. Prescott, for instance, uses a longer 31-stage data pipeline. The longer pipeline will make it easier to increase clock speeds, but it also slows performance. Prescott also seems to leak energy more readily than Northwood, causing it to run hotter.

The 3.4GHz Extreme Edition includes 8KB of L1 Data cache. The 512KB of L2 cache is half the size of Prescott's 1024KB of L2, but the 2MB of on-die, full-speed L3 cache more than makes up for the smaller L2. The L3 cache helps in processor-intensive applications such as gaming and video editing. Rather than the longer, slower 31-stage pipeline, the 3.4GHz Extreme Edition uses a 20-stage pipeline. Although it's based on Northwood, the 3.4GHz Extreme Edition's 102.9W power dissipation is more similar to Prescott's 103W power dissipation than high-end Northwood P4's 82W power dissipation. Despite the higher power dissipation, the 3.4GHz Extreme Edition has the same 1.525V to 1.6V operating voltage as a standard 3.4GHz Northwood. This is higher than the 1.25V to 1.4V operating voltage for Prescott processors. Our version of the 3.4GHz Extreme Edition uses Intel's basic Socket 478 interface. At press time, however, Intel had announced a new 3.4GHz Extreme Edition and a new 3.6GHz Prescott that uses an LGA motherboard interface. Given more time, we would've loved to take one or both processors for a spin, but announcements were made much too close to press time.

Furthermore, the 3.4GHz Extreme Edition proved itself in earlier testing, reaching speeds of 3.85GHz. We also managed some exceptional benchmark scores, depending on which motherboard we paired the processor with.

Processor, Motherboard & Drivers: AMD System	
Processor	AMD Athlon 64 FX-53
Motherboard	ASUS SK8V
BIOS Manufacturer	American Megatrends
BIOS Version	AMI Bios 2003 (Asus Version 1002)
Chipset Driver	VIA 4.51 (K8T800)
Common Components	
RAM	Corsair PC2700 registered DDR SDRAM (2 x 1GB)
Video	Gainward PowerPack! Ultra/ 1800 XP Golden Sample (GeForce FX 5950 Ultra)
Hard Drive	80GB Western Digital WD800JD 7,200rpm SATA
Mod Kit	Prometia AMD 64 EasyMod Kit
Phase Change Cooler	Prometia Mach II
CD-ROM	LiteOn Black 48X/24X/48X/16X DVD/CD-RW
Floppy	Samsung 1.44MB
Power Supply	Antec 430W TruePower
Case	Antec PLUS1080AMG
Temperature Monitor	MacPower Digital Doc 5

Speaking of motherboards, a high-end processor demands a high-end mother-board. We decided on using Chaintech's 9CJS Zenith, as it too proved itself in earlier testing by providing solid performance scores and good overclocking options. We managed to get a 3.2GHz Extreme Edition processor running at 3.65GHz on the same board and posted consistently high benchmark scores.

The Zenith board includes Intel's 875P chipset on the northbridge. The 875P includes support for an 800MHz FSB and dual-channel PC3200 DDR SDRAM. The Chaintech board includes an Intel ICH5R on the southbridge, which means support for SATA RAID 0 or 1. We'll be sticking with straight-up SATA hard drive configuration in this article, however, and leave RAID for another day.

Chaintech includes a number of nice extras with its Zenith board, including integrated 7.1 surround-sound audio and Gigabit Ethernet. The CBOX3 comes with the Zenith board and mounts in an external 5.25-inch drive bay. The CBOX3 includes front USB and FireWire ports along with a 6-in-1 card reader for removable media such as SD and Memory Stick. The board also includes the Handigator remote control. Both the Handigator and CBOX3 are nice features, but we didn't mess with either as they added nothing to the motherboard's performance.

We did keep our test system components as similar as possible with the exception of our system memory. With the new Socket 939 Athlon 64s still too new to procure, we had no choice but to use registered DDR SDRAM in our Athlon 64 FX-53 test system. We saw no need to handicap our Extreme Edition because of AMD's memory restrictions, and used unbuffered DDR SDRAM on our Intel test system.

Overclocking. Headquartered in the Midwest, below zero temperatures are nothing new to us. In fact, we had a habit of huddling around Athlon XP processors for heat back in the day. What we're not used to, however, is having a processor that's colder than a February morning. We strapped the motherboard, processor, and memory into our Mach II enabled chassis, connected the Mach II to the processor using the Prometeia Intel Easy Mod Kit, attached our drives and cards, and then got ready to crank up the voltage.

Before we overclocked to 11, we had to play scientist and record some default scores. Considering our motherboard and processor had both proven themselves previously, we were fairly confident we'd start out with some strong default scores. The 3.4GHz Extreme Edition didn't disappoint, managing a 6750 3Dmark03 score at its default 3.4GHz clock speed. The score was well above the Athlon 64 FX-53's 6302 default 3Dmark03 score, but still about

69 points less than the Athlon's overclocked 3Dmark03 score.

PCMark04 scores were equally strong. In fact, all of our PCMark04 default scores except for the HDD score were better than the Athlon 64 FX-53 highest overclocked scores. At 5700, the Overall PCMark04 score was more than 900 points better than the Athlon 64 FX-53's default PCMark04 Overall score and almost 400 points better than the best PCMark04 score. The 3.4GHz P4's 5330 CPU score was 862 points better than the Athlon 64 FX-53's default CPU score and 186 points better than Athlon 64's overclocked CPU score. One reason we choose the Chaintech 9CJS Zenith board is because it seems to provide some excellent PCMark04 Memory scores. The Extreme Edition's 5496 Memory score was significantly better than the FX-53's 4859 default Memory score and slightly better than the FX-53's 5333 overclocked Memory score. Paired with our NVIDIA graphics card, the 3.4GHz Extreme Edition managed an impressive 5706 Graphics score that eclipsed both the FX-53's default 5288 Graphics score and its 5467 overclocked Graphics score. When it came to HDD performance, however, the FX-53's 4766 was almost 300 points better than the 4373 posted by Intel's 3.4GHz Extreme Edition.

We were able to easily increase the FSB to 210MHz, but this caused a slight performance setback as our 3Dmark03 score fell slightly to 6728. Our system rebooted when we tried to increase the FSB to 220MHz, so we scaled it back to 215MHz. At 3.71GHz, our processor rebounded nicely with a 6847 3Dmark03 score. We were able to increase the FSB to 216MHz without any problems and a very slight 6-point 3Dmark03 increase. We were able to increase our 3Dmark03 score another 16 points to 6869 by increasing the FSB to 217MHz.

We began to have problems as we increased the processor's clock speed to 3.76GHz and FSB to 218MHz. At this speed, 3Dmark03 failed to complete successfully. Increasing the FSB to 1.6V, however, managed to fix our stability problems and we posted a 6776 3Dmark03 score. Our celebration was short lived as our benchmarks failed at 219MHz. We had to increase the CPU voltage to 1.65V in order to get the system stable. Our 3.77GHz processor yielded a 6884 3Dmark03 score. We were able to push the processor's clock speed to 3.79GHz by increasing the FSB to 220MHz, but the 3Dmark03 score fell slightly to 6871. Attempts to further overclock the system were unsuccessful.

The Extreme Edition system yielded its best score at 3.77GHz, so we reset the FSB to 219MHz and ran PCMark04. The Intel system was already dominating the AMD system before we even started the overclocking, and increasing our system's speed just seemed to pile it on. Our PCMark04 Overall score rose 395 points to 6095 and the CPU score increased to 5817. We saw a hefty gain in our Memory score as it rose to 6023, while our Graphics score showed a modest increase to 5720. The only PCMark04 score to lag behind the AMD system was the 4347 HDD score.

Conclusion

Unfortunately, this contest was over even before it had really begun. Our 3.4GHz Pentium 4 had managed to beat the best overclock scores the Athlon 64 FX-53 could muster. In fact, we had managed to top the Athlon 64 FX-53's refrigerator-assisted scores with simple aircooling previously in this issue. Although the Extreme Edition captured the performance crown, AMD showed the biggest increase in performance. We were able to increase the FX-53 400MHz from 2.4GHz to 2.8GHz, and the extra 400MHz bought us an extra 379 points in 3Dmark03.

We weren't actually able to push the Intel processor quite as far, perhaps partly due to Intel's locked multiplier. The Extreme Edition was only able to gain an extra 370MHz, and 3Dmark03 improvements were a measly 121 points. Of course, the Extreme Edition started out with a default 3Dmark03 score that was 69 points higher than the FX-53's overclocked 3Dmark03 score.

As we've seen, however, the chipset plays as important a part in the system's overall performance as the processor itself. Socket 940 pickings are a little scarcer than Socket 478 options. The Extreme Edition certainly owes a great deal of its success to the 875P-based Chaintech 9CJS Zenith motherboard. From a price/performance standpoint, however, AMD may well be ahead of Intel. AMD's 940-pin FX-53 costs about $800, while Intel's Socket 478 3.4GHz Pentium 4 Extreme Edition costs nearly $200 more. CPU

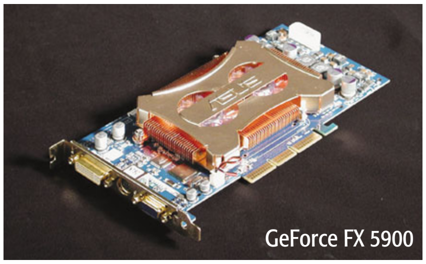
by Joshua Gulick and Chad Denton

Processor, Motherboard & Drivers: Intel System	
Processor	3.4GHz Pentium 4 Extreme Edition
Motherboard	Chaintech 9CJS Zenith
BIOS Manufacturer	Phoenix Award BIOS
BIOS Version	Ver 6
Chipset Driver	5.0.2.1002
Common Components	
RAM	1GB PC4000 DDR SDRAM (4 x 512MB)
Video	Gainward PowerPack! Ultra/ 1800 XP Golden Sample (GeForce FX 5950 Ultra)
Hard Drive	80GB Western Digital WD800JD 7,200rpm SATA
Mod Kit	Prometeia Intel CPU EasyMod Kit
Phase Change Cooler	Prometeia Mach II
CD-ROM	LiteOn Black 48X/24X/48X/16X DVD/CD-RW
Floppy	Samsung 1.44MB
Power Supply	Antec 430W TruePower
Case	Antec PLUS1080AMG
Temperature Monitor	MacPower Digital Doc 5

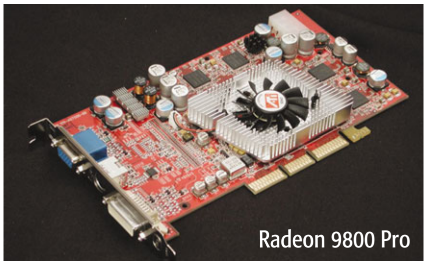
ATI & NVIDIA SQUARE OFF

Where Things Stand Between The GPUs & VPUs

We set out to find the definitive answer to who makes the best graphics cards. Outfitted with a generous budget and more than a little bit of hubris, we purchased three cards featuring some of the fastest VPUs and GPUs from each manufacturer. We tested each card on the same machine, recorded the results, and tallied the scores to see who makes the fastest chip. We also reserved some additional time for hands-on gaming.


GeForce FX 5900

GeForce FX 5950 Ultra


Radeon 9800 Pro

Our test rig specs: 2GHZ AMD Athlon 64 3200+, 1GB (2 x 512MB) of Kingston HyperX PC3200 DDR RAM on an Asus K8V Deluxe motherboard (with VIA K8T800 chipset), a Seagate Barracuda ST380013AS 80GB SATA hard drive, and a Lite-On Black LTC-48161H 48X/24X/48X/16X CD-RW/DVD drive. For ATI cards we used the latest Catalyst 4.4 driver, and for NVIDIA cards we used the ForceWare 56.72. The machines ran on an Antec Original TRUE 430W P4 power supply with Windows XP Pro as the OS.

We chose cards that were OpenGL- and DX9-compatible. On the NVIDIA side, we selected an ASUS v9950 TVD GeForce FX 5900, a Gainward GeForce FX5900 Ultra, and a Leadtek GeForce FX 5950 Ultra. In ATI's corner, we chose a Sapphire Radeon 9800SE, a Radeon 9800 Pro (also from Sapphire), and a Radeon 9800 XT.

Our battery of tests ran through AquaMark3, Halo, 3Dmark2001SE, 3Dmark03 (using Futuremark's 340 patch), Quake III Arena, Unreal Tournament 2003, and our timedemo created in Unreal Tournament 2004. Quake III tests were run at resolutions of 1,024 x 768 and 1,600 x 1,200 and AquaMark3 tests were run at the program's default resolution, 1,024 x 768. Halo tests were conducted at 1,600 x 1,200 with and without AA/AF at full.

You may wonder why we set up a graphics card challenge between ATI and NVIDIA without ATI's X800 XT or NVIDIA's GeForce 6800 Ultra. Well, it's because neither was available at retail at the time of this writing. They will be by the time you read this, so watch for comparisons later on.

Equally regrettable is that our results were not as definitive as we had hoped for; that's to say, none of the six cards we selected emerged as a clear winner, so it would be unfair to suggest that our comparison will put an end to the ATI vs. NVIDIA debate. On the contrary, it may be like putting out fire with gasoline.

The Fast And The Not So-Furious

Let's get straight to what matters most: speed. Behind reliability and API support, speed is probably the most important factor users consider when purchasing a new card.

In this category, we had no obvious winners, but the Radeon 9800SE from Sapphire stood for lackluster performance. In 3Dmark2001SE and 3Dmark03 tests, the Radeon 9800SE turned out scores of 13611 and 3315. That's 3536 and 2103 marks slower than the next slowest card, the ASUS GeForce FX 5900. Throughout our AquaMark3 tests, the Radeon 9800SE consistently showed scores that were much lower than what the GeForce FX 5900 produced. For instance, the average default score in AquaMark3 for the GeForce FX 5900 was about 38517. The Radeon 9800SE was 13843 marks lower at 24674.

The 9800SE produced similar results across the board, including scores of 11.11 in Halo at a 1,600 x 1,200 resolution. In the UT2003 Anatalus and Phobos2 tests, the card showed frame rates of 37.1 and 51 at a resolution of 1,600 x 1,200, which are average to say the least, especially in this competition.

The rest of the cards were well-matched at their core clock speeds. All three NVIDIA cards have higher clock speeds (475MHz, 450MHz, and 400MHz) than the ATI cards (412Mhz, 380MHz, and 325MHz), but in the benchmarking competition, the NVIDIA cards failed to take a clear lead. In fact, if any card had an edge over the others, it was ATI's Radeon 9800XT, which uses a default core clock speed of 412MHz and an effective memory clock of 730MHz but scored 1000 marks higher at 45864 in AquaMark3 tests than the GeForce FX 5950 Ultra.

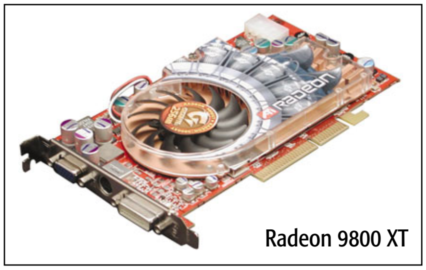
The Radeon 9800XT also outperformed the other cards in 3Dmark2001SE and 3Dmark03 tests, scoring 20354 and 6521, respectively. In the same tests, the GeForce FX 5950 Ultra, the fastest of the NVIDIA cards, scored 18475 and 6214.

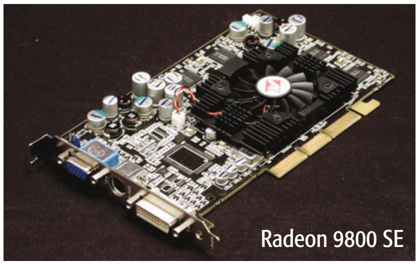
The Radeon 9800 Pro, with default core clock and memory clock speeds that are actually quite typical for most Radeon 9800 Pros (380/680), scored 19191 in 3Dmark2001SE and 5786 in 3Dmark03 while the GeForce FX 5900 Ultra produced similar scores of 18064 and 5962. In most tests the ATI Radeon 9800XT narrowly beat out the fastest NVIDIA card, the GeForce FX 5950 ULTRA.

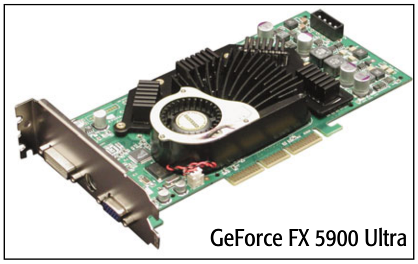
To The Extreme

Overclockers will not be disappointed by how these cards perform when pushed beyond their manufacturer-recommended limits. In particular, there is the example of the Gigabyte Radeon 9800 XT and the Gainward GeForce FX 5900 Ultra. We were able to rev the Radeon 9800 XT's 412MHz core clock and 365MHz memory clock to 450/400. The GeForce FX 5900 shot up to 530/930 from a 450MHz core clock and 850MHz memory clock (effective). A year ago most gamers would have been thrilled to have a card reach the 5000 mark in the 3Dmark03 test. When overclocked, the Radeon 9800XT broke 7000 (7057). Even the slightly older generation cards, the Sapphire ATI Radeon 9800SE and the ASUS GeForce FX 5900, showed a good deal of overclocking potential. In addition to raising the core clock and memory clock speeds of the Radeon 9800 XT from 412/365 to 450/400, we were able to overclock the Radeon 9800 Pro to 420/375, up from 380/340.

The NVIDIA cards showed proficient gains, as well. The GeForce FX 5950 Ultra overclocked at 490/965 (effective), up from 475/950. The FX 5900 Ultra did even better. It overclocked at 530/930 (effective), up from 450/850. And the GeForce FX 5900 went from a 400MHz core clock and 850MHz (effective memory clock), to 464/905.


Radeon 9800 XT


Radeon 9800 SE


GeForce FX 5900 Ultra

Not yet surprised? We've got more: Even the Radeon 9800SE turned out to be a good overclocker. In fact, it showed better gains than many of the other cards. We were able to boost its paltry 325MHz core clock speed to 380MHz. That equals out to a gain of about 17% (although, even when overclocked, the Radeon 9800SE pales in comparison to all the other cards in this roundup).

Obviously, each of the six ATI and NVIDIA cards turned out to be excellent overclockers. In general, the ATI cards overclocked better than the NVIDIA cards, but to be fair, the NVIDIA cards started out with higher core clock speeds.

OK, so enough with the numbers. You want to know how these cards held up during actual game play, right? We played several sessions of DX9 and lower games, including (but not limited to) Battlefield 1942, Unreal Tournament 2003, Desert Combat, and Unreal Tournament 2004. Each game was played at the highest possible resolution.

When it comes to displaying real-time graphics, any of the top two ATI or NVIDIA cards will suffice. As you might expect, we didn't experience any lockups with those four cards. Nor did we notice any jerky frames. But the two lower-end cards were a different story.

The Radeon 9800SE performed the way you might expect a midrange card to perform. It ran more like a card from the Radeon 9600 series. We half expected that after recording the card's benchmarking results. The NVIDIA GeForce FX 5900 was equally as disappointing. Make no mistake: It's still a mighty powerful video card, but it struggled (albeit slightly) during graphic-intensive levels, such as those found in levels of Unreal Tournament 2004 featuring vehicles.

Bundle, Bundle–Who's Got the Bundle?

The question now becomes, "Which company offers the best extras?" It's a question that can be unfair because so much of what goes into a package depends upon the card manufacturer and not the chipset developer. Still, it's worth mentioning, if at least briefly, to suggest who has the better business partners. Keep in mind that we purchased the two Sapphire cards OEM.

As far as software bundles go, Sapphire is at a bit of a disadvantage here. If we had purchased, say, the full retail version of the Radeon 9800 Pro Atlantis instead of the OEM bulk version, we might have received Soldier of Fortune II and Return To Castle Wolfenstein—perhaps even Tomb Raider, at the very least. As it is, we instead received PowerDVD 5 and a slew of accessories, including VGA-to-DVI adapter, power cable, S-Video cable, and composite cable.

The Radeon 9800XT offered a lot more. Gigabyte not only included a free coupon for a copy of Half-Life 2, the company also threw in PowerDVD 5, Tomb Raider: Angel Of Darkness, Tom Clancy's Rainbow Six 3: Raven Shield, and Will Rock.

In addition, the Radeon 9800XT came with adapters, S-Video cable, composite cable, and "Y" power cable. With our GeForce FX 5900 Ultra, we got a power cable and pink—more like fuchsia—VGA-to-DVI adapter and video-out cable with composite in, composite out, S-Video in, and S-Video out connections. From Leadtek, in addition to our FX 5950 Ultra, we also got a few video-editing CDs and two DirectX 9 games: GunMetal and Big Mutha Truckers. With the GeForce FX 5900, we got Asus Home Theater software, Power Director Pro, a host of games including Battle Engine Aquila, Black Hawk Down, Gun Metal, and a 6-in-1 games showcase disc, and few additional accessories, such as a VGA-to-DVI adapter.

Perhaps the most important impact of these goodies—at least as far as this head-to-head is concerned—is their price. It's not easy to say who offers the best extras for the buck, but in this competition one thing is certain, the highest priced cards offer some of the best treats (though Tomb Raider: Angel Of Darkness can be had on eBay for as little as a cent).

And The Award Goes To . . .

Roll out the red carpet. The award for the fastest card and the best performance goes to the Gigabyte ATI Radeon 9800 XT with its 8-pixel pipeline, SmartShader 2.1, and Smoothvision 2.1 technology.

This was by no means an easy competition for the Radeon 9800 XT. Take a look at the chart, and you'll notice that the LeadTek GeForce FX 5950 Ultra, which uses NVIDIA CineFX 2.0 engine and Intellisample HCT (high-resolution compression technology), actually has the better specs—note that the GeForce FX 5950 Ultra has a much higher core clock than the Radeon 9800 XT (about 50MHz higher). It's cheaper, too, at $380, while the Radeon 9800 XT cost us $428. Still, you can expect the ATI X800 Pro and the GeForce 6800 to leave both of these cards in the dust.

As with the award for the fastest card, picking a winner for best overclocked card was also difficult. The GeForce FX 5900 Ultra produced a bigger jump in performance than the Radeon 9800 XT, but it still couldn't compete with the Radeon 9800 XT's final results. When set at its maximum core clock and memory clock speeds of 450MHz/400MHz, the Radeon 9800 XT produced scores of 21135 in 3Dmark2001SE, 7057 in 3Dmark03, and 48289 in AquaMark3.

In the end, it appears ATI is poised to sweep the competition. It had the fastest, best-performing card—and one that also produced the most impressive overclocking results. NVIDIA will have to settle for giving ATI a good run for the money until we can test the next-gen retail parts.

by Eric Melvin Reed

By The Numbers

Here are the actual results for the six cards we tested. Note that the overclocked results are presented in brackets. You've got a lot of numers to look through, but the numbers tell the story.

Video Card	**Gigabyte ATI Radeon 9800 XT**	**Sapphire ATI Radeon 9800 PRO**
Price	$428 (retail)	$205 (OEM)
Interface	AGP 8X	AGP 8X
Chipset	ATI Radeon 9800 XT	ATI Radeon 9800 Pro
RAM	256MB DDR	128MB DDR
Core Clock	412MHz	380MHz
Memory Clock Actual (Effective)	365MHz (730MHz)	340MHz (680MHz)
Overclocked Maximums (core clock/memory clock in megahertz)	450/400	420/375
Max. Resolution	2048 x 1536	2048 x 1536
Refresh Rate At Max. Resolution	85Hz	85Hz
APIs Supported	DirectX 9.0, OpenGL 2.0	DirectX 9.0, OpenGL 2.0
Operating Systems	Windows 98/ME/2000/XP	Windows 98/ME/2000/XP
3Dmark2001 SE		
3D Marks	20354 [21135]	19191 [20391]
Fill Rate (single texture)	2194.5	2013.3
Fill Rate (multitexture)	3246.4	2984.7
3Dmark03		
3D Marks	6521 [7057]	5786 [6365]
Fill Rate (single texture)	1842.9	1691.3
Fill Rate (multitexture)	3169.6	2908.6
Quake III Arena at 32-bit		
1,024 x 768	306.1	301.2
1,600 x 1,200	237.7	223.9
Unreal Tournament 2003 at 32-bit (average fps)		
Anatalus 1,024 x 768	201.5	188.7
Anatalus 1,600 x 1,200	94.8	86.7
Phobos2 1,024 x 768	197.7	188.4
Phobos2 1,600 x 1,200	117.6	108.1
Unreal Tournament 2004 at 32-bit*		
1,600 x 1,200	25.31	24.83
AquaMark3 at 32-bit		
Default Test	45864 [48289]	43436 [46445]
GFX	6158 [6575]	5717 [6242]
CPU	8977 [9086]	9044 [9070]
Halo		
1,600 x 1,200	27.17	25.17
1,600 x 1,200 (AA/AF at full)	21.94	21.97
Phone	(626) 854-9338	(909) 594-0597
URL	www.giga-byte.com	www.sapphiretech.com

*Custom Demo: DeathMatch DesertIsle map

Sapphire ATI Radeon 9800SE	**Leadtek GeForce FX 5950 Ultra**	**Gainward GeForce FX 5900 Ultra**	**ASUS GeForce FX 5900**
$136 (OEM)	$380 (retail)	$339 (retail)	$260 (retail)
AGP 8X	AGP 8X	AGP 8X	AGP 8X
ATI Radeon 9800SE	nVidia GeForce FX5950 Ultra	nVidia GeForce FX5900 Ultra	nVidia GeForce FX5900
128MB DDR	256MB DDR	256MB DDR	128MB DDR
325MHz	475MHz	450MHz	400MHz
290MHz (580MHz)	475MHz (950MHz)	425MHz (850MHz)	425MHz (850MHz)
380/340	490/965	530/930	465/905
2048 x 1536	2048 x 1536	2048 x 1536	2048 x 1536
85Hz	85Hz	85Hz	85Hz
DirectX 9.0, OpenGL 2.0	DirectX 9.0, OpenGL 1.5	DirectX 9.0, OpenGL 1.4	DirectX 9.0, OpenGL 1.4
Windows 98SE/ME/NT/2000/XP	Windows 98/ME/NT/2000/XP, Linux	Windows 98SE/ME/NT4.0/2000/XP	Windows 98/ME/NT/2000/XP
13611 [15813]	18475 [18706]	18064[19286]	17147 [18232]
991.5	1746.5	1666	1512.6
1288.5	3467.9	3296.7	2955.1
3315	6214 [6391]	5962 [6721]	5418 [6011]
924.4	1537.5	1480.2	1366.7
1280.1	3365.2	3206.7	2867.2
239.2	319.9	320.1	314.5
92.7	256.6	247.2	231.7
88.1	209.7	204.4	188.4
37.1	107.1	102.4	89.3
110.7	207.5	203.5	191
51	121.2	116.1	102.1
26.1	25.29	25.31	25.26
24674 [30428]	44803 [46111]	42955 [48763]	38517 [43556]
2852 [3653]	5921 [6146]	5600 [6635]	4865 [5702]
9130 [9082]	9206 [9222]	9219 [9202]	9233 [9220]
11.11	27.06	24.9	22.43
9.41	20.52	20.13	17.82
(909) 594-0597	(510) 490-8076	(510) 252-1118	866 2 28943447 (Taiwan)
www.sapphiretech.com	www.leadtek.com	www.gainwardusa.com	www.asus.com

compiled by Marty Sems

THE GREAT VIDEO CARD PYRAMID

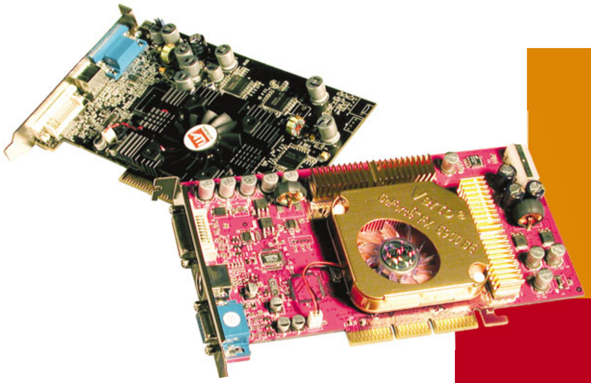
How 3D Cards Stack Up

Even with just two major discrete graphics processor manufacturers, it's still easy to get overwhelmed by the alphabet soup of 3D card names. It helps to visualize ATI VPU and NVIDIA GPU families as a pyramid, with the affordable chips on the bottom and the expensive screamers on top. Here are the chip families currently listed by ATI and NVIDIA at press time—more or less—with example cards and prices as available. Prices are from Pricegrabber.com and Pricewatch.com except for the cards we tested. For those cards, we listed the prices we paid.

NVIDIA

GeForce 6800 Ultra $499
GeForce 6800 GT
GeForce 6800

GeForce FX 5950 Ultra Leadtek GeForce FX5950 Ultra, 256MB DDR, $380 3Dmark03: 6214 Q3A: 256.6fps UT2003: 107.1fps
GeForce FX 5950 eVGA e-GeForce FX5950, 256MB DDR, $445
GeForce PCX 5950 (PCI Express)



GeForce FX 5900 XT MSI GeForce FX 5900XT, 128MB, $186
GeForce FX 5900 Ultra Gainward GeForce FX5900 Ultra, 256MB DDR, $339 3Dmark03: 5962 Q3A: 247.2 UT2003: 102.4
GeForce FX 5900 GigaByte GeForce FX 5900, 128MB DDR, $189
GeForce FX 5900 SE PNY GeForce FX5900 SE, 128MB DDR, $185 3Dmark03: 5179 Q3A: 224.1 UT2003: 84.5

GeForce PCX 5750 (PCI Express)

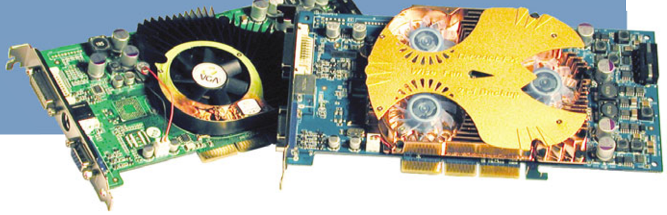
GeForce FX 5700 Ultra eVGA GeForce FX5700 Ultra, 128MB DDR2, $165 3Dmark03: 3910 Q3A: 173.9 UT2003: 58.3
GeForce FX 5700 Gainward GeForce FX 5700, 256MB DDR, $125
GeForce FX 5700LE XFX GeForce FX 5700 LE, 256MB DDR, $116

GeForce FX 5600 Ultra Abit Siluro GeForce FX5600 Ultra OTES, 128MB DDR, $195 3DMark03: 3245 Q3A: 162.4 UT2003: 54.1

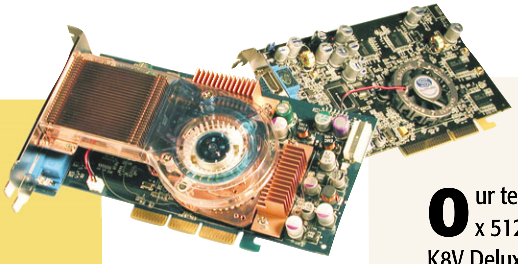
GeForce FX 5500 AOpen GeForce FX 5500, 128MB DDR, $79 3DMark03: 1120 Q3A: 50.1 UT2003: 16.4

GeForce PCX 5300 (PCI Express)

GeForce FX 5200 Ultra BFG Technologies GeForce FX5200 Ultra, 128MB DDR, $99 3Dmark03: 2005 Q3A: 115.8 UT2003: 31.4
GeForce FX 5200 Chaintech GeForce FX5200, 128MB DDR, $56



ATI



Radeon X800 XT Platinum ATI Radeon X800 XT Platinum Edition, $499
Radeon X800 XT ATI Radeon X800 XT, 256MB DDR, $399
Radeon X800 Pro ATI Radeon X800 Pro, 256MB DDR, $358

Radeon 9800 XT Gigabyte Radeon 9800XT, 256MB DDR, $428
3Dmark03: 6521 Q3A: 237.7fps UT2003: 94.8fps
Radeon 9800 Pro Sapphire Radeon 9800 PRO, 128MB DDR, $205 (OEM)
3Dmark03: 5786 Q3A: 223.9 UT2003: 86.7
All-In-Wonder Radeon 9800 Pro ATI Radeon 9800 Pro All-In-Wonder, 128MB DDR, $327
Radeon 9800 ATI Radeon 9800, 128MB DDR, $190
Radeon 9800 SE Sapphire Radeon 9800 SE, 128MB DDR, $134
3Dmark03: 3315 Q3A: 92.7 UT2003: 37.1

Radeon 9700 Pro PowerColor Radeon 9700 Pro, 128MB DDR, $248
All-In-Wonder Radeon 9700 Pro ATI Radeon 9700 Pro All-In-Wonder, 128MB DDR, $399
Radeon 9700 ATI Radeon 9700, 128MBDDR, $249 3Dmark03: 5167 Q3A: 200.5 UT2003: 77.5
All-In-Wonder Radeon 9700 ATI Radeon 9700 All-In-Wonder, 128MB DDR, $213

Radeon X600 (PCI Express)

Radeon 9600 XT ATI Radeon 9600XT, 128MB DDR, $152 3Dmark03: 3834 Q3A: 125.7 UT2003: 45.5
All-In-Wonder Radeon 9600 XT ATI All-In-Wonder Radeon 9600 XT, 128MB DDR, $249
Radeon 9600 Pro Sapphire Radeon 9600 PRO, 128MB DDR, $129.50 3Dmark03: 3426 Q3A: 113.8 UT2003: 42.7
All-In-Wonder Radeon 9600 Pro ATI Radeon 9600 Pro All-In-Wonder, 128MB DDR, $249
Radeon 9600 Sapphire Radeon 9600, 256MB DDR, $100
All-In-Wonder Radeon 9600 ATI All-In-Wonder Radeon 9600, 128MB DDR, $160
Radeon 9600 SE Asus Radeon 9600 SE, 128MB DDR, $74

Radeon X300 (PCI Express)

Radeon 9200 Pro (DX8.1)
Radeon 9200 ATI Radeon 9200, 128MB DDR, $92 (DX8.1) 3Dmark03: 1223 Q3A: 63.8 UT2003: 21.9
Radeon 9200 SE Gigabyte Radeon 9200 SE, 128MB DDR, $45 (DX8.1)

Radeon 9000 Pro ATI Radeon 9000 Pro, 64MB DDR, $82 (DX8.1)
All-In-Wonder Radeon 9000 Pro ATI All-In-Wonder RADEON 9000 Pro, 64MB DDR, $143 (AGP 4X, DX8.1) 3Dmark03: 1443 Q3A: 74.8 UT2003: 23.7
Radeon 9000 Sapphire Radeon 9000, 64MB DDR, $30 (DX8.1)

How We Tested

Our test PC had a 2GHz Athlon 64 3200+, 1GB (2 x 512MB) of Kingston HyperX DDR400, an Asus K8V Deluxe motherboard, an Antec True 430W power supply, a Seagate ST380013AS 80GB SATA hard drive, and a Lite-On LTC-48161H 48X CD-RW/DVD drive. The OS was Windows XP Pro SP1; drivers were ATI's Catalyst 4.4 and NVIDIA's ForceWare 56.72.

Test results are for a stock card without overclocking, antialiasing, or anisotropic filtering. For a synthetic benchmark, we ran the DirectX 9-aware 3Dmark03 Build 340 and reported each card's overall score. In real-world frame rate tests, we chose games that were playable throughout the pyramid, which meant they're a few steps back from the DX9/PS2/PS3 frontier of today's titles. We ran Quake III Arena's Demo001 at 1,600 x 1,200 with 32-bit color to get the frame rates shown. Likewise, we ran Unreal Tournament 2003's Antalus demo at 1,600 x 1,200 x 32. All cards are AGP 8X unless noted. ▲

WHAT A DIFFERENCE A DRIVE MAKES

How A New Hard Drive Affects Your Rig's Overall Performance

What difference does your hard drive make? It's just for data storage, right? Well, right. But if you spend all your money on a flashy CPU and RAM and go cheap on a slow hard drive, your rig may stall instead of scream.

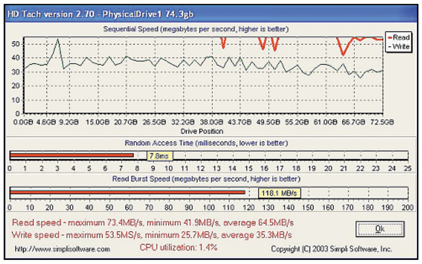
Your computer probably spends more time waiting for data from the hard drive than from any other device (leaving your dial-up modem out of this). If your hard drive is a slowpoke, it will delay everything you try to do with your PC.

In order to understand what makes one hard drive faster than another, it helps to know how they work. A hard drive stores bits of data as magnetic charges on rigid aluminum or glass disks, often called platters. The drive moves read/write heads back-and-forth across the platters as they spin at 5,400rpm (revolutions per minute) or more, always keeping the heads a tiny distance above the disks' surfaces. The electromagnetic heads read data from and write it to the platters' magnetic recording layers.

Because it takes a few milliseconds to find data on a hard drive, which is actually a long time to a computer, a drive has some memory called a cache buffer. These few megabytes store the last data the drive was asked to retrieve. If the computer asks for the same data again before new bits overwrite it, the cache can supply it much faster than if the drive had to physically find the data again on the disks.

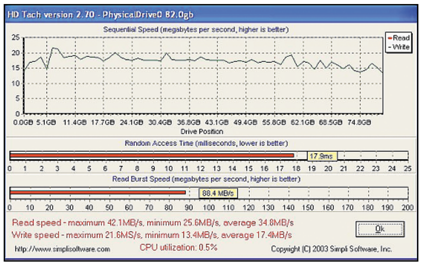
Manufacturers use a bag of tricks to speed up hard drive performance. They spin the drive's platters faster for spindle speeds of 7,200rpm, 10,000rpm, or even 15,000rpm. They bump up the cache buffer from 2MB to 8MB. They pack more storage space onto each platter for a higher areal density (GB per platter), so that the drive's heads read more data with each revolution of the disks. Hard drive manufacturers also refine the electronics in the drive for smarter data request management.

To handle these higher speeds, vendors give their drives faster interfaces (connectors, cables, and the circuitry to send data over them) with which to communicate with the PC. Although interfaces such as ATA/133 (Advanced Technology Attachment/133 megabytes per second), SATA/150 (Serial ATA/150MBps), and Ultra320 SCSI (Small Computer System Interface, 320MBps) don't speed up a drive by themselves, they do allow swifter drives to send data to the PC at their top speeds without an unnecessary bottleneck in between.


HD Tach version 2.70 - PhysicalDrive1 74.3gb
Sequential Speed (megabytes per second, higher is better)
Read
Write
50
40
30
20
10
0
0.0GB 4.6GB 9.2GB 15.0GB 20.7GB 26.5GB 32.2GB 38.0GB 43.7GB 49.5GB 55.2GB 61.0GB 66.7GB 72.5GB
Drive Position
Random Access Time (milliseconds, lower is better)
7.8ms
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Read Burst Speed (megabytes per second, higher is better)
118.1 MB/s
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200
Ok
http://www.simplisoftware.com
Copyright (C) 2003 Simpli Software, Inc.

```
Read speed - maximum 73.4MB/s, minimum 41.9MB/s, average 64.5MB/s
Write speed - maximum 53.5MS/s, minimum 25.7MB/s, average 35.3MB/s
CPU utilization: 1.4%
```

Here's a raw comparison of drive speeds, courtesy of HD Tach 2.70. Western Digital's 10,000rpm Raptor chews up a mousy 5,400rpm drive and spits it out.


HD Tach version 2.70 - PhysicalDrive0 82.0gb
Sequential Speed (megabytes per second, higher is better)
Read
Write
25
20
15
10
5
0
0.0GB 5.1GB 11.4GB 17.7GB 24.1GB 30.4GB 36.8GB 43.1GB 49.4GB 55.8GB 62.1GB 68.5GB 74.8GB
Drive Position
Random Access Time (milliseconds, lower is better)
17.9ms
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Read Burst Speed (megabytes per second, higher is better)
88.4 MB/s
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200
Ok
http://www.simplisoftware.com
Copyright (C) 2003 Simpli Software, Inc.

```
Read speed - maximum 42.1MB/s, minimum 25.6MB/s, average 34.8MB/s
Write speed - maximum 21.6MS/s, minimum 13.4MB/s, average 17.4MB/s
CPU utilization: 0.5%
```

If your PC doesn't support an interface you want to use, you can probably find a SATA, Ultra160, or Ultra320 SCSI adapter card to add to one of the motherboard's PCI slot. Fortunately, all interfaces are backward compatible to some extent with their earlier and slower speed steps. For example, an ATA/133 adapter should handle an ATA/100 drive with no problems.

How We Tested

There's a point at which the costs of the fastest hard drives outweigh their speed advantages, at least for a desktop computer or gaming PC. To give you a better idea of what you're really getting at each technological tier, we benchmarked a system with a variety of internal drives. These ranged from an ATA/133 5,400rpm economy unit to an Ultra320 SCSI 10,000rpm server denizen (our 15,000rpm SCSI server drive was DOA). We tested each drive by itself, and noted our results in the "What's The Diff With Drives?" chart in this article.

We tried to minimize as many differences as we could by sticking to Maxtor drives at or near 80GB of capacity. Of course, some variation was inevitable, as no manufacturer sells a hard drive platform that extends from 5,400rpm to 10,000rpm with the same platter diameter and areal density. Also, to date only Western Digital's Raptor has 10,000rpm SATA credentials.

Our test PC had a 3.2GHz P4, 1GB (512MB x 2) of Kingston HyperX DDR400 (PC3200), an Asus P4P8X mainboard, an ATI Radeon 9800 XT video card with 256MB DDR, a 48X Lite-On LTC-48161H CD-RW/DVD-ROM drive, and an Antec PLUS1080AMG 430W power supply. The motherboard supplied ATA/133 and SATA headers, and we turned to an Adaptec 19160 Ultra160 card for our Ultra320 SCSI drive (the 160MBps throughput limit shouldn't affect a single drive with a measured 107.7MBps burst read speed).

We ran HD Tach 2.70 on each bare drive and then formatted them and installed a drive image incorporating WinXP Pro SP1, 3Dmark03, PCMark04, and Halo. Setting each drive as the sole boot device, we ran our synthetic benchmarks for an overview of how the system would handle gaming and typical tasks. Next, we timed how long it took each drive to load Halo, and ran the game's Timedemo at 1,600 x 1,200 resolution and 32-bit color depth to see if its frames per second rate was affected. We used the latest drivers, BIOS, and patches available.

Finally, we took case temperature readings in the middle of our Futuremark benchmarks for each drive. Faster-spinning drives usually generate more heat, so we wanted to gauge their effect on the rest of the system. We kept the case closed throughout our tests. This particular case had ample 80mm Antec cooling fans—one side intake and two rear exhausts—plus the power supply's output fan. Although it's a rather unusual configuration, it's more typical of an enthusiast's case setup than would be a mainstream case with a single intake fan balancing the power supply's air output. Special thanks to Coby "They Stole My Monitor" Boring for his help in the testing lab.

Maxtor DiamondMax 16 ATA/133 80GB (4R080L0)

5,400rpm
2MB cache
$59

For our baseline hard drive, we chose a type that many mainstream users get with their plain-vanilla, name-brand PCs. A 5,400rpm EIDE drive with a 2MB cache provides the most storage per dollar, but no one will call it peppy. An entry-level drive like this makes an excellent backup unit, though. It's quiet and it runs cool.

Maxtor invented the ATA/133 interface several years ago, yet to date only Samsung joins the company in building ATA/133 drives. Seagate, Hitachi GST, and Western Digital continue to use the ATA/100 interface. Either interface is fine for typical drive usage.

What's The Diff With Drives?

Some benchmarks show off faster drives, and some don't. Like a car's handling, you have to feel the difference in many cases. Note that with even moderate airflow, none of these drives raised case temperatures much.

	Maxtor ATA-133 DM16 5,400rpm 2MB 80GB	**Maxtor ATA-133 DM+9 7,200rpm 2MB**	**Maxtor ATA-133 DM+9 7,200rpm 8MB 80GB**	**Maxtor SATA DM+9 7,200rpm 8MB 80GB**	**WD SATA Raptor 10,000rpm 8MB 74GB**	**Maxtor Ultra320 SCSI Atlas IV 10,000rpm 8MB**
PCMark04	4901	4952	4916	4909	4965	5000
Processor	4876	4800	4816	4861	4871	4848
Memory	4456	4501	4467	4436	4447	4502
Graphics	4546	4544	4545	4539	4541	4539
Hard drive	2783	3178	4019	4072	5660	4433
3Dmark03	6438	6443	6453	6443	6444	6448
HD Tach 2.70 Max. read (MBps)	42.1	67.5	65.7	53.3	73.4	68
Average read (MBps)	34.8	49.4	48.8	45.2	64.5	48.2
Max. write (MBps)	21.6	30.2	20.3	14.8	53.5	42.1
Average write (MBps)	17.4	22.9	12.8	13.1	35.3	34.5
Random access (ms)	17.9	21.1	14.7	14.2	7.8	7.9
Burst read rate (MBps)	88.4	87.2	87.5	112.7	118.1	107.7
Halo load time (sec.)	:45	:42	:42	:42	:42	:44
Average FPS	25.25	25.93	25.9	26.05	26.57	26.49
Case temp. (C)	31.1	33	32.4	33.5	31.2	30.7

The main points from our test results are PCMark04's System score of 4901 and Hard Drive rating of 2783. Other highlights are Halo's 45-second load time and 25.25fps rating; a case temperature of 31.1 degrees Celsius; and HD Tach scores of 42.1MBps maximum/34.8MBps average reads, 21.6MBps max/17.4MBps avg writes, and 17.9ms random access time. PCMark's other categories and 3Dmark03 didn't change much over the rest of our testing, so we'll let the numbers in the chart speak for themselves.

Maxtor DiamondMax Plus 9 ATA/133 80GB (6Y080L0)

7,200rpm
2MB cache
$74

Read, write, and access speeds get a boost when you move from the 5,400rpm level to 7,200rpm. That's a 33% increase in spindle speed, although that doesn't translate to a proportional jump in real performance. Remember that our comparisons can't be apples-to-apples, as this DiamondMax Plus 9 is a different model than the DiamondMax 16 in the previous example.

The DM+9 is obviously speedier than the 5,400rpm DM16 in its HD Tach results, although the long access time reported by the software is likely a fluke. Read speeds of 67.5MBps max/49.4MBps avg and quick write rates of 30.2MBps max/22.9MBps avg get our blood pumping. This 7,200rpm number charted an equally impressive tally of 3178 in PCMark04's Hard Drive test, a substantial 14% increase.

However, these benchmarks only focus on drive performance, not the whole story. We were chagrined to see that all that extra drive speed bought us was another 1%, or 4952, in PCMark's overall system test. Halo loaded three seconds faster, or 6.7%, and gained a 2.7% better frame rate at 25.93fps. All this came with a 1.9-degree temperature rise to 33 degrees (6.1% more).

Maxtor DiamondMax Plus 9 ATA/133 80GB (6Y080P0)

7,200rpm
8MB cache
$83

For just a few bucks more—$9 in this case—your 7,200rpm drive can quadruple its cache memory. That can mean smoother video playback, quicker defragmentation, and fewer delays moving from level to level in video games. A bigger cache doesn't really offer a noticeable speed boost in everyday usage, but you'd probably miss it if you switched back to a drive with 2MB cache.

While a top desktop drive today can only read at a maximum of about 67MBps, its cache can send its data at a rate nearer to the interface's theoretical max speed. That's about 133MBps for ATA/133 and 150MBps for SATA. The bigger cache in this case gave us a beautiful 26.4% increase in PCMark04's Hard Drive benchmark, to 4019 points.

Unfortunately, the rest of our tests didn't reflect any other benefits attributable to the extra buffer memory. Besides HD Tach's reported decrease in write rates, which was probably another example of this iffy software's occasional tomfoolery over the past few versions, all other benchmarks were flat or slightly down after the change.

Maxtor DiamondMax Plus 9 SATA 80GB (6Y080M0)

7,200rpm
8MB cache
$82.50

The desktop hard drive industry has shifted to the Serial ATA interface, although manufacturers will likely keep making ATA/EIDE drives for a while. This drive is basically the DM+9 converted to SATA with a bridge chip, so its PCMark scores are almost identical to the ATA/133 model above.

HD Tach liked the SATA DM+9 even less, reporting slashed read and write rates that no other benchmark reflected. HD Tach did claim a huge 28.8% increase in burst read speed to 112.7MBps, but be aware that reads from cache are too sporadic and brief to be noticeable in many applications.

Finally, Halo's 26.05fps score demonstrated a 5.8% boon, but the 33.5-degree case temp was the highest of all the drives—even the 10,000rpm ones. It's still well within the comfort zone, though.

Cables & Connectors

Most hard drives in desktop PCs use the ATA (Advanced Technology Attachment) interface, also called EIDE (Enhanced Integrated Drive Electronics), DMA (Direct Memory Access), IDE, UltraATA, or UltraDMA. EIDE drives' data cable connectors have 39 or 40 pins, although ATA/66 /100/133 (66MBps [megabytes per second] to 133MBps) data cables have double that number of wires.

Many new desktops now come with SATA (Serial ATA) hard drives, which have black, L-shaped male cable connectors in back. SATA cables are much skinnier than EIDE cables, even rounded ones. However, many SATA drives require a special power supply connector or adapter, as regular 4-pin Molex connectors won't fit them. The new SAS (Serial Attached SCSI) interface for servers uses the same cables and connectors. Some systems can even support both SAS and SATA.

Most servers and some enthusiast PCs use Ultra160 (160MBps) or Ultra320 SCSI (Small Computer Systems Interface) hard drives. Current SCSI drives use 68-pin or 80-pin data cables; earlier editions used 25-pin or 50-pin cables. FC-AL (Fibre Channel-Arbitrated Loop) is another server interface, but you probably won't find it in any PCs.

External hard drives are usually EIDE drives converted to use USB 2.0 (60MBps) or FireWire (50MBps) interfaces. Newer externals may use FireWire 800Mbps (100MBps) or SATA to connect to a PC, or even 100Mbps Ethernet to hook up to a network router. ▲

Western Digital Raptor SATA 74GB (WD740GD)

10,000rpm
8MB cache
$215

The next step up in performance is 10,000rpm, heretofore a spindle speed reserved for server drives, not desktop units. Western Digital is still the only purveyor of a 10,000rpm SATA drive, so we'll include its Raptor 74GB as an aside to all our Maxtors.

Basically a low-end SCSI drive built with the SATA interface, the Raptor proved to be the best performer of our group after our seventh contestant bowed out. The problem is that, like SCSI drives, it's expensive. You could almost buy three SATA or ATA 80GB drives for the price of this 74GB Raptor (and have a nice, fast RAID [redundant array of independent disks/drives]). It's definitely for the enthusiast with cash to blow.

Monstrous PCMark04 Hard Drive and HD Tach scores show the Raptor's strengths. Its 5660 points in the former represent a tremendous 39% jump, while its 73.4MBps max/64.5MBps avg reads and 53.5MBps max/35.3MBps avg writes in the latter walk tall. The higher spindle speed accounts for the whip-snapping 7.8ms access time.

Does all this make for peppier PCMark04 and Halo speeds? Surprisingly, no. But our test PC definitely felt fastest with the Raptor on board. And case temps were as cool as with the 5,400rpm drive above.

Maxtor Atlas IV Ultra320 SCSI 73.5GB (8B073L0)

10,000rpm
8MB cache
$281

Even more than raw speed, SCSI drives' forte is fast access for multiple users, as in a Web or file server. Hence, our single-drive desktop usage pattern reflected in the benchmarks we used don't play to the SCSI Atlas IV's strengths. (Upcoming SATA drives with NCQ [native command queuing] from Seagate and others hope to reach SCSI-like data management speeds.)

Put simply, high prices and relatively low capacity have kept SCSI drives out of most users' PCs. Heat output from their higher spindle speeds is also a concern, but it didn't factor much into our case temperature measurements. In fact, 30.7 degrees was the coolest temp we recorded.

Despite the Atlas IV's slim victory in overall PCMarks, 5000 points, the rest of its scores fell between the 10,000rpm SATA Raptor's and the 7,200rpm Maxtors. Curiously, it took a couple of seconds longer to load Halo than most of the pack.

After we bought this article's drives, Maxtor announced new Atlas SCSI drives: the 10,000rpm Atlas 10K V (up to 300GB) and the 15,000rpm Atlas 15K II (up to 147GB). Speaking of 15K drives, we had intended to include results from Maxtor's $510 Ultra320 SCSI 15000 with 8MB cache (8C073L0), but it wouldn't format or run HD Tach.

Hard Advice

Hard drive speed does play a significant role in a PC's performance level, although this speed manifests itself differently in various applications. For example, PCMark04's overall system score may tell you that a PC with a SATA 10,000rpm Raptor is only 1.3% swifter than one with a timid, 5,400rpm drive. However, PCMark's Hard Drive test will paint the Raptor system as more than 200% faster. The real truth is somewhere in the middle.

All else being equal, your best buy for a typical gaming and surfing rig is a 7,200rpm SATA drive with an 8MB cache. SATA is the wave of the future, and 8MB drives don't cost much more than their 2MB counterparts.

If your budget allows you to consider a Raptor or SCSI drive, look into buying multiple SATA drives for a RAID instead. But RAID is a whole 'nother topic. . . . CPU

---

by Marty Sems

Chill Out

Although the ball or fluid dynamic bearings in a hard drive let the platter spindle spin with extremely little friction, hard drives do generate heat. In general, the faster the spindle speed, the hotter a drive will get. If it isn't cooled by good airflow through the computer case, a hot drive will wear out and fail much sooner than normal.

As enthusiasts began buying faster and faster drives, hard drive coolers became more popular accessories. These typically attach to or enclose a drive, using one or more fans to circulate air over it. Some examples are Vantec's Ultra Thin HDC502A aluminum cooler ($8) and Cooler Master's LHD-V04 CoolDrive4 ($38).

A cooler is a good idea for a 10,000rpm drive, and almost essential for a 15,000rpm one. We used to be able to say that you didn't need a cooler for 7,200rpm and slower drives. These days, though, more users are building or buying SFF (small form factor) computers that are short on space.

"Some kind of cooling can be appropriate and necessary if a modder is using a nonstandard enclosure in which unusual heat buildup results from packing things close together or restricting airflow," says Seagate spokesman John Paulsen. "In other words, you certainly can't say 7,200rpm hard drives will never heat up in any situation."

Also, says Paulsen, not all users have air conditioning, and some live in hotter climes than others. These users, and especially ones with multidrive servers, should consider coolers.

Finally, Paulsen says, "look at the spec sheet to see what kind of energy output comes from the drive and what temperatures it's designed to operate in." For instance, Seagate's Cheetah 15K.3 SCSI drive shouldn't run at case temperatures above 55 degrees Celsius (131 degrees Fahrenheit), so use some type of cooler or improve your server's airflow if your case swelters at temps above that. ▲

DO MOTHERBOARDS MATTER?

One Chipset, Six Combatants

It's often been said that the motherboard, the main circuit board in a computer, gives a system its personality. This is more true than it appears, which you'll find out if your cheap, colorful mobo's personality turns out to be a bad one. Sporty and psycho can be fun for a while, but over time, you'll yearn to trade up to something more stable.

After comparison shopping you may find that several reputable manufacturers offer mainboards with the features you want and prices you're willing to pay. They might even have the same chipset or complement of support chips. But, you may ask, will any of these boards be materially better or faster than the rest? Does it really matter which board you buy?

We love a good head-to-head around here, so we decided to throw six ATX mobos into the pit of conflict. Each of them had a VIA K8T800 northbridge and VT8237 southbridge, and each had a 754-pin socket for the AMD Athlon 64s available at this writing.

All our boards came from the mainstream price range, about $77 to $119. Each had similar features, more or less, such as AGP 8X/4X, SATA RAID, and DDR400 support. Most also had bigger brothers with more features, too. If you don't see the FireWire port or built-in wireless support you're looking for here, check the manufacturers' sites for more upscale models.

How We Tested

We fitted each motherboard with the same processor, RAM, and other components and then tested it with a game-heavy suite of benchmarks. Our test part list incorporated an Athlon 64 3000+ with 512KB of L2 cache and a Gigabyte GH-PCU21-VG 3D heatsink and fan on top. Two sticks of 512MB HyperX PC3200 DDR SDRAM from Kingston gave us a total of 1GB of memory. A Maxtor DiamondMax Plus 9 SATA hard drive with a 7,200rpm spindle speed and 8MB of cache (model 6Y080M0) and a Lite-On 52X CD-ROM handled storage requests. We installed a Gigabyte Radeon 9800XT video card with 256MB of DDR, and fired everything up with an Antec SL400 400W power supply. Each mobo received the latest drivers and BIOS updates available.

Our benchmarking portfolio started off with PCMark04 from Futuremark. This synthetic benchmark gave us reasonable estimates of each board's aptitude with general tasks. For gaming, we tested with Futuremark's synthetic 3Dmark03 and Microsoft's Halo Timedemo. We set both to 1,600 x 1,200 resolution with 32-bit color depth.

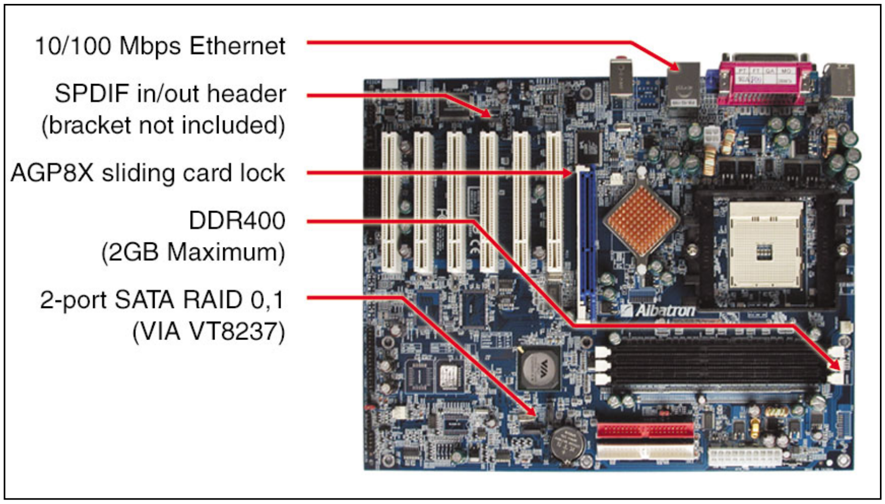
Finally, we overclocked each board's frontside bus and noted how high it could go with stability. The CPU, heatsink, RAM, and, of course, chipset were the same in each test, so it was really intriguing to see the effect each board had on the level of overclocking we were able to achieve.

There may be more pleasant company than six nice motherboards for a rainy Tuesday morning, but by now her bodyguards recognize us on sight. Special thanks to Andy "Knife To A Gunfight" Gerace and Jeff "Jolt Cola" Roberts for their help in the testing lab.

Albatron K8X800 Pro v.1.1

We paid: $98

Warranty: 3 years labor, 1 year parts


10/100 Mbps Ethernet
SPDIF in/out header (bracket not included)
AGP8X sliding card lock
DDR400 (2GB Maximum)
2-port SATA RAID 0,1 (VIA VT8237)
Albatron

Kicking off the festivities in alphabetical order is this contestant from Albatron. The K8X800 Pro looks ver-a nice-a with its pretty, dark teal color and its cool copper northbridge heatsink. The latter has cylindrical pins instead of fins, and invites second glances.

Like most mainboards for the Athlon 64, the Albatron has a plastic bracket bolted through it and surrounding the 754-pin socket. The bracket offers a stronger mounting foundation for the bulky, heavy heatsinks of today's power-hungry processors than would the socket itself.

The K8X800 Pro can only support a maximum of 2GB of DDR400 (PC3200) SDRAM, but that's the limit for the rest of the boards in this article, too. It can handle up to 3GB of DDR333/266/200, although that's still less than the 4GB limits of earlier boards that supported only the lower speeds of RAM. That's the reality on the ground today, so to speak, and it's still more memory than most power users may need in a PC. It reflects the limitations of DDR1 at FSB frequencies of 400MHz and beyond. (By the way, AMD would like us to forgo the use of the term "frontside bus" regarding the Athlon 64/Opteron families, as the processors directly link to the RAM using built-in memory controllers.)

The Albatron's two SATA headers won't go far when more optical drives go serial, but that's more of a concern for the future. The VIA VT8237 southbridge offers SATA RAID configurations 0 and 1. Albatron provided a SATA power adapter, but no SATA data cables for some reason. The company did include two ATA/133 ribbon cables and a floppy drive cable, though.

A Realtek ALC655 chip provides mighty nice 5.1-channel audio. There's an SPDIF input/output header on the K8X800 Pro, but no corresponding jack bracket came with our board. However, there's a four-port USB bracket in the kit, which complements the two integrated ports and extra two-port header for a total of eight Hi-Speed USB 2.0 ports.

This Pro version of the K8X800 had the optional, built-in 3Com 10/100Mbps LAN connection but not the VIA VT6307 chip for 400Mbps FireWire support. In a nod to portability, Albatron endowed the AGP 8X slot with a sliding card locking mechanism to avoid embarrassing fallout.

The K8X800 Pro's six PCI slots are easy to spot from orbit, but you'd need a more oblique view to spy the legacy MIDI/gameport, parallel port, and 9-pin serial connectors. There are also PS/2 mouse and keyboard jacks, which will probably hang on longer than expected until pre-OS and sleep mode USB support is no longer an iffy proposition.

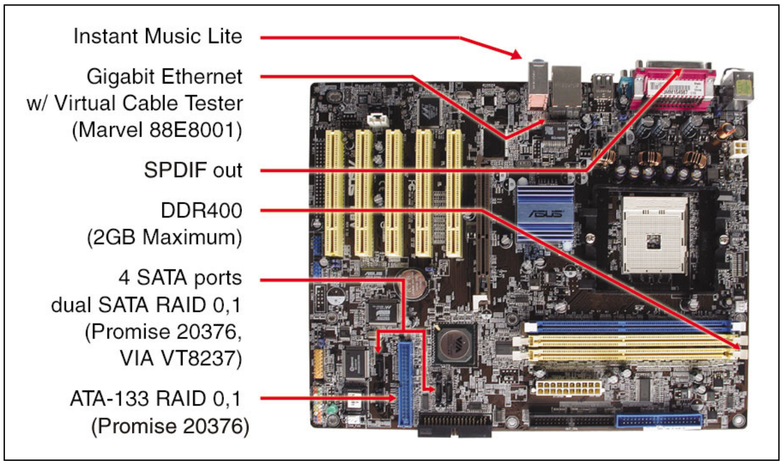
The Albatron's software bundle is pretty typical. It includes Trend Micro PC-cillin 2002 antivirus, Adobe Acrobat Reader, and Microsoft DirectX 9.0b. The company also provides a sticker with a map of the mobo, plus diagrams of its jumper settings and switch/LED headers.

This motherboard falls into the middle of the pack price-wise and synthetic benchmark performance-wise. It overclocked less than the rest, though, and its Halo score was dead last by a laser's width. But at the risk of deflating the drama somewhat, keep in mind that the overall benchmark scores only varied from each other at most by 2.9%.

Asus K8V-UAYZ Rev. 1.12

We paid: $119

Warranty: 3 years


Instant Music Lite
Gigabit Ethernet w/ Virtual Cable Tester (Marvel 88E8001)
SPDIF out
DDR400 (2GB Maximum)
4 SATA ports dual SATA RAID 0,1 (Promise 20376, VIA VT8237)
ATA-133 RAID 0,1 (Promise 20376)

Trusty brand Asus has finally followed the competition's lead. Not in any substantial or technical way, of course; rather, the manufacturer is now adding a bit of color to its heretofore staid mainboards. You'll find five yellow PCI slots on the K8V-UAYZ, for example, plus yellow and blue RAM slots (three slots for DDR400, 2GB maximum DDR400, 3GB maximum DDR333/266/200). The PCB is a stately brown color that clashes just a little with a tasteful blue northbridge heatsink.

This Asus has an AMCO heatsink bracket, but its backing plate is stamped metal in contrast to the Albatron's plastic brace. The plate doesn't contact the mainboard under the socket, but it still might play a role in dissipating heat from the sink.

An RCA/coaxial SPDIF output comes built into this board's back panel port cluster. Upstream of it is an ADI AD1980 SoundMAX audio chip pumping out 5.1-channel sound. Like the rest of the boards in this article, the K8V-UAYZ supports AGP 8X. At this writing, PCI Express has yet to crest the horizon and bathe us all in its blessed bandwidth. No real biggie, of course, as most users don't even need all of AGP 8X's headroom just yet.

Asus offers dual SATA RAID (0 and 1) on this mobo through a Promise 20376 controller and the southbridge. The VT8237 is likely the faster bet, as it doesn't have to squeeze SATA's 150MBps potential through the 133MBps PCI bus as the Promise chip must. Four SATA ports beckon. Asus even provided three SATA data cables with our kit.

As for ATA/133, the K8V-UAYZ features a third ATA/133 header with RAID 0 and 1 capabilities, thanks to the Promise 20376 mentioned above. Ribbon cables include two ATA/133s, one ATA/33 for optical drives, and a floppy drive cable.

A Marvell 88E8001 controller supplies the Gigabit Ethernet connectivity, but Asus added its Virtual Cable Tester feature to sense network line quality. Four USB 2.0 ports are integrated into the backplane, with four more available via headers without extensions. There are the usual token legacy ports, but no MIDI/gameport except through another header sans bracket. You were just about to upgrade to a USB joystick anyway, weren't you?

As always, Asus packs a comprehensive manual with this board. It will walk you through the K8V-UAYZ's many "value-added" features, some of which are relatively novel. For example, Instant Music Lite lets you play an audio CD (not an MP3 or other music file disc) through the board's integrated audio channel, all without booting up to your operating system. You'll use the ESC and function keys F1 through F6 to toggle Instant Music Lite on or off, adjust volume, play or stop, and skip tracks.

Overclocking Standings (FSB)

Below are the increases in FSB frequency over stock we achieved:

Gigabyte GA-K8VT800M	12.5%
Epox EP-8HDA3+	8.5%
MSI K8T NEO-FSR	8.00%
Asus K8V-UAYZ	7.5%
Chaintech SK8T800	7.5%
Albatron K8X800 Pro	5.5%

Another point of interest is CrashFree BIOS 2, which is simply a backup of the original BIOS and recovery mechanism on the installation CD. Our longtime friend Q-Fan offers automatic fan speed adjustment to reduce noise during periods of light CPU loads. In a similar vein, Cool'n'Quiet! adjusts the processor's voltage and frequency as needed. This can cut power consumption and heat output. Finally, there's C.P.R., or CPU Parameter Recall, which resets the BIOS settings to default in case of a hang due to overclocking.

Speaking of o/c, Asus offers fine 1MHz adjustments for the FSB (200 to 300MHz) and .025V increments for CPU voltage (1.750V to 0.800V), among other related settings. There's the familiar sticker map of the mobo, jumpers, and switch/LED headers, plus PC-cillin 2002 Antivirus, Asus PC Probe, and Acrobat Reader on CD.

In stock trim, the Asus took the 3Dmark03 and PCMark04 speed crowns, for what they're worth. It tied the Chaintech Summit SK8T800 for fourth place in raw overclockability. We should add that we've had fewer problems with Asus boards over the years than any other brand, and that three-year warranty is among the longest here.

Chaintech SK8T800

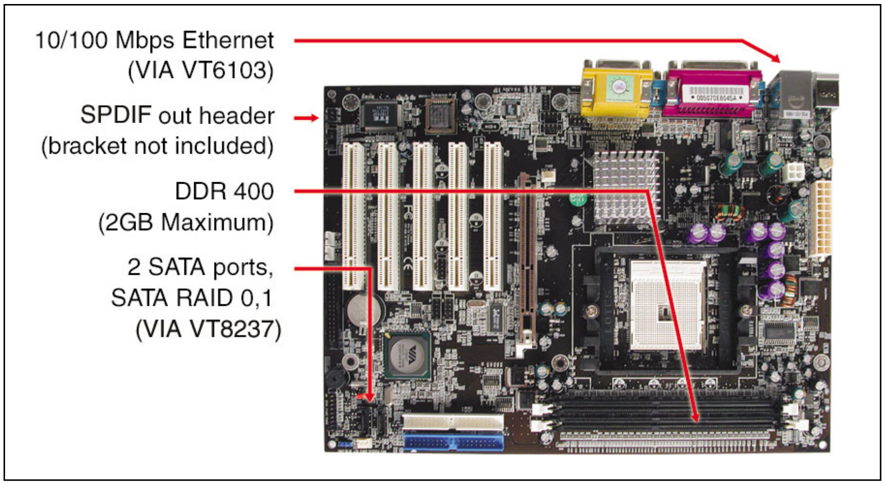
We paid: $77
Warranty: 1 year

What a bargain! If you're looking for SATA RAID, 100Mbps Ethernet, and Athlon 64 support in a $77 package, Chaintech has it. With savings like this, a quick-and-dirty gaming system with a top-notch graphics card can be more affordable than you think.

Like the other vendors showcased here, Chaintech makes use of the VIA southbridge to enable SATA RAID 0 and 1. The company doesn't supply any SATA data cables for the board's two headers, but it does ante up with a SATA power adapter. Kudos to Chaintech for saving users a trip to the geek store.

VIA's VT6103 controller gives the SK8T800 its 10/100Mbps LAN connectivity. It's no Gigabit port, but it's sweetened by its wake-on capability over a network.

The 5.1-channel audio is all but expected these days, and happily, the board's SPDIF output header is becoming a more commonplace feature, as well. There's no extension for SPDIF, however. The six ports' worth of USB 2.0 headers didn't come with any brackets, either, although there are two fixed USB 2.0 ports in the rear I/O cluster. Chaintech grudgingly ponied up one ATA/133, one ATA/33, and one floppy ribbon cable.


10/100 Mbps Ethernet (VIA VT6103)
SPDIF out header (bracket not included)
DDR 400 (2GB Maximum)
2 SATA ports, SATA RAID 0,1 (VIA VT8237)

Two DDR400/333/266 slots support up to 2GB on this austere board, which like the Asus has a dark brown PCB. The only color comes from the legacy ports and the capacitors around the socket. Said legacy ports include a second 9-pin serial port and a MIDI/gameport. A LOTES plastic brace through the board gives the heatsink a firm footing.

In short, the low-buck SK8T800 packs several essentials such as AGP 8X/4X and 10/100Mbps LAN, and straps SATA RAID on top for kicks. However, its documentation is minimal. Chaintech also skips a lot of the extras, such as I/O brackets and bonus software, although it should be said that most of the software that other boards in this price bracket bundle are free to download anyway.

We're also leery of that brief one-year warranty. However, Chaintech's tech support did respond to an email query the same day, which is saying something.

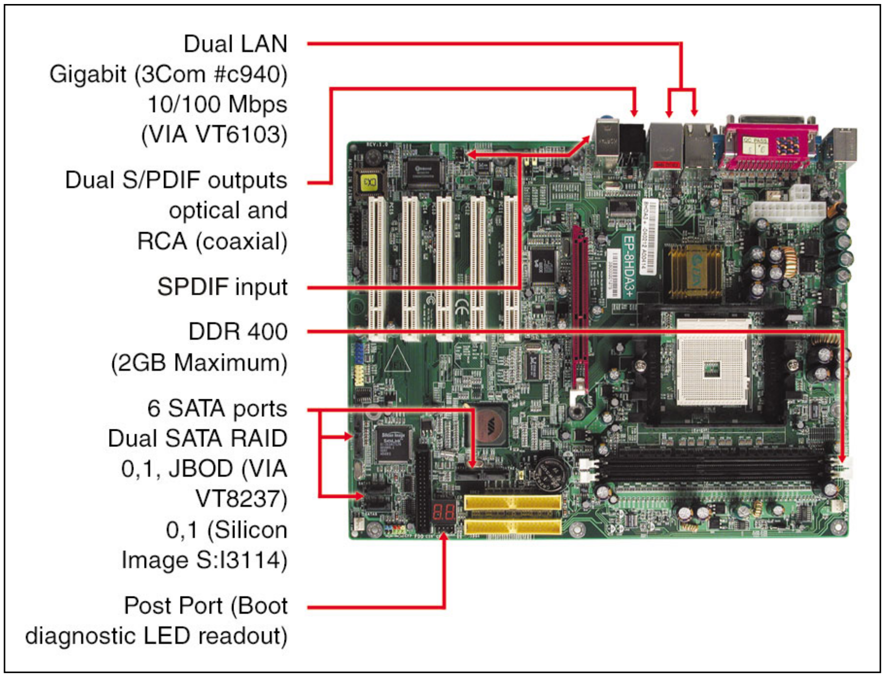
Epox EP-8HDA3+ Rev. 1.0

We paid: $111
Warranty: 2 years

You want I/O? You got it. For eleventy-one bucks, Epox manages to cram in the connectivity of a mainboard costing twice as much.

Epox's exercise in excess kicks off with integrated dual LAN. The primary horse is a Gigabit Ethernet connection managed by 3Com's 3C940 controller. The old, grey mare next to it is a 10/100Mbps nag born of VIA's VT6103. Sure, she's still serviceable, but 10/100 Ethernet just ain't what she used to be.

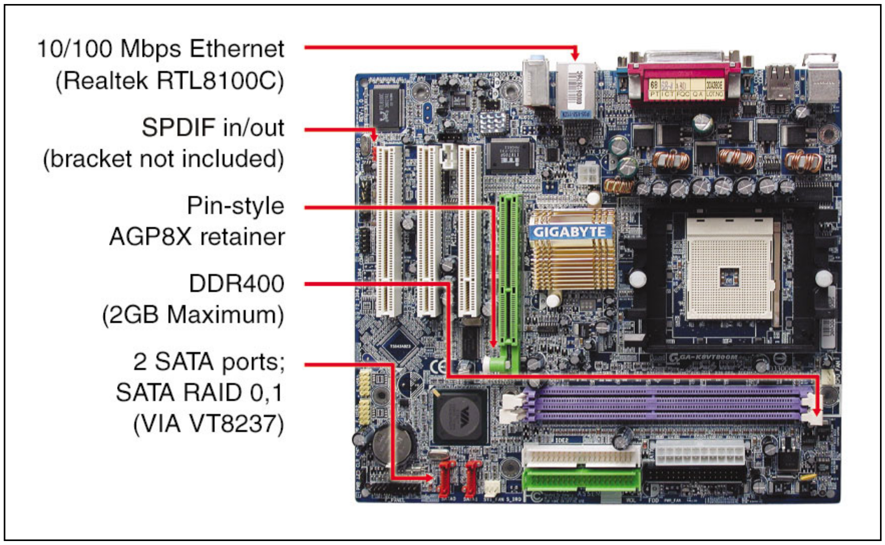
Another really cool extra is a second built-in SPDIF output port. One is the RCA/coaxial style, and the other is optical. The latter has a spring-loaded door that flips out of the way when you insert a cable connector. It won't get lost like the typical removable black plastic plug. The board



even supports SPDIF input through its Line-out jack or a dedicated pin-header (no extension supplied). The 5.1-channel audio is courtesy of a Realtek ALC655 codec, and there's even jack sensing to detect whether you've attached speakers, headphones, or some other device.

The I/O laundry list turns next to storage. You'll count a whopping six SATA headers on the EP-8HDA3+ for hard and (future) optical drives. They're RAID-capable, too, thanks to the Silicon Image SiI3114 (RAIDs 0 and 1) and VT8237 southbridge (0, 1, and JBOD). Mind you, the SiI3114 is on the 133MBps PCI bus, so you'll probably want to keep your RAID 0 on the VIA controller. Not one to skimp, Epox supplies two each of SATA cables and power adapters, plus an extension cable that adds an external SATA data port to an expansion port bracket. That bracket also has a MIDI/gameport jack.

Curiously, both the users manual and a leaflet from Epox promise future support of RAIDs 5 and 10 through BIOS and driver updates. Well, we'll see. With dedicated RAID 5 cards costing nearly twice the price of this entire motherboard, it would be a coup for Epox to offer it as an add-in that doesn't require a later revision of the board. We've been burned before by other manufacturers' promises, such as new processor and FSB speed support that only materialized with Rev. 2.0 boards, so we take this one with a bit of skepticism.



Reasoning that Athlon 64 buyers like their RAM in pairs, Epox skipped a third DIMM slot on the EP-8HDA3+. The board can use up to 2GB of DDR400. Its frequency and voltage settings are satisfactorily granular for overclocking, and indeed, the motherboard came in second in our o/c standings.

"Retro" probably isn't the right term for this board's Radio-Shack-green PCB, but it does look good with its understated, gold-tinged northbridge heatsink. The EP-8HDA3+ sports four integrated USB 2.0 ports, so we won't razz Epox for leaving out extension cables for the headers for four more. The company included the usual ATA/133 and floppy ribbons.

Notable features, besides a thorough manual that rivals Asus's efforts, include Post Port. This is a P80P LED readout on the PCB that can report boot error codes. If you encounter a hang after an optimistic overclock, you can revert your system to default settings by pressing INSERT at startup. Finally, EZ Boot lets you choose the boot device by pressing ESC at startup rather than mucking around in the CMOS settings each time.

The EP-8HDA3+'s software CD included PC-cillin 2002 and Adobe Reader 6.0. Although all the artwork suggested we were getting Symantec's Norton Ghost, as well, it turned out to be Norton Personal Firewall 2003 instead. Shucks. On the bright side, Epox thoughtfully included the SATA and SATA RAID drivers on diskettes to save you a step when you're building your system.

Options we didn't get with our sample were 1394a FireWire and ATA/133 RAID. However, we did get an embossed Epox case badge and a "what the?" folding Epox desk calendar. More importantly, the company's tech support answered our online query about warranty coverage within an hour or two.

Gigabyte GA-K8VT800M Rev. 1.0

We paid: $95
Warranty: 3 years limited

In Gigabyte's K8 Triton series comes this 754-pin, four-layer board. It's named according to the company's love of long strings of alphanumeric characters, but at least its model number doesn't look like a phonetically spelled sneeze (GA-K8NNXP! Gesundheit.)

The GA-K8VT800M is small, about 8.5 inches x 9.5 inches, to appeal to users who want to assemble tinier systems and media boxes. It's also a nice teal color, although you won't be able to tell under the dense white silkscreening around every component and contact. You'll only get three PCI slots because of the smaller form factor, but the northbridge heatsink distracts you from this fact with some extra visual zip.

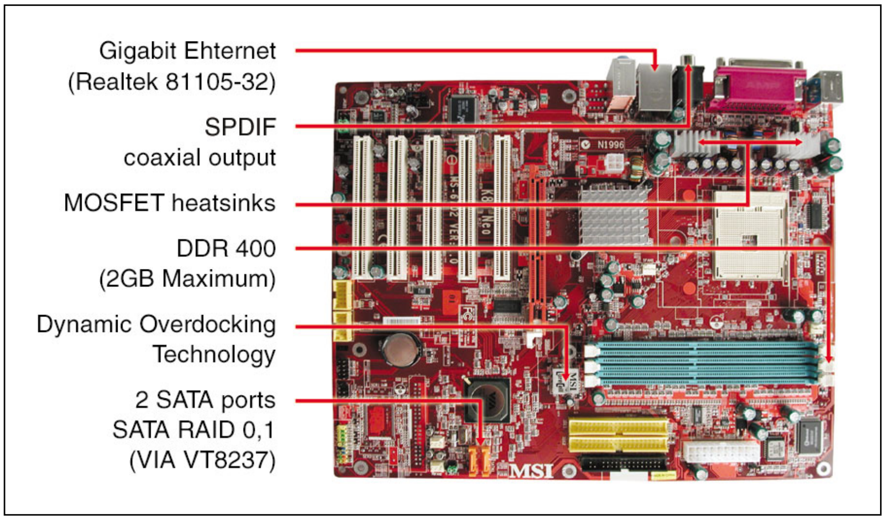
Like the Epox EP-8HDA3+, this Gigabyte has but two DDR400/333/266/200 slots and a 2GB RAM maximum. There are eight USB 2.0 ports in sum, although the four that aren't integrated lie unfulfilled as headers without supplied extensions. Gigabyte did package a SATA, an ATA/133, and a floppy cable with the board. The RAID 0 and 1 options for the GA-K8VT800M's two SATA ports are the work of the VT8237 southbridge.

A 10/100Mbps LAN comes standard on this board, thanks to a Realtek RTL8100C controller. In keeping with a small PC's portability, the AGP 8X/4X graphics slot gets a retractable pin-retainer mechanism so the video card stays put. Note that AGP 2X cards are not supported.

Moving from video to audio, the GA-K8VT800M gets jack-sensing, 5.1-channel surround sound connections from an ALC655 chip. The ALC655 even brings SPDIF input and output to the table, but these are routed through a pin header for which there's no extension bracket. Phooey. There's also no bracket for the MIDI/gameport header. In any case, your PS/2 keyboard and mouse, parallel port printer, and external serial dial-up modem all have homes on the back panel. Heck, there's even a leftover 9-pin serial port in case you have to reconfigure an old broadband modem or router.

This Gigabyte lagged behind in our synthetic benchmarks, but it emerged from the overclocking scrap as the champ with a 12.5% FSB increase to 225MHz. Its o/c opportunities include a CPU host clock adjustment range of 200MHz to 455MHz, plus a Windows-based utility called EasyTune 4 for tweaking the RAM, AGP, and FSB. There's also an Auto Optimize mode in case you'd rather let the board adjust itself.

Besides its overclocking trophy, the GA-K8VT800M also won our Halo fps competition. Not that there's a lot of drama in being 2.9% faster than the slowest mobo of the six, but a win's a win. By the by, Gigabyte's tech support did reply to a question we had within a business day, but the department skips email contact in favor of an odd login message system on the Web site.



MSI K8T Neo-FSR (MS-6702) v.1.0

We paid: $93
Warranty: 3 years parts, 2 years labor from date of manufacture

This contender from Microstar was the only motherboard in our group to have passive heatsinks on its MOSFETs. Those sinks are part of MSI's LifePro feature, which aims to extend the K8T Neo-FSR's life.

This Neo was also the only board in this article that came with a rounded, two-device ATA/133 cable, in red to match the PCB. Even the floppy drive cable was folded, sleeved in a black mesh, and secured with heat shrink tubing. These cables will allow better airflow around them, helping your system to run cooler. MSI threw in two SATA data cables, plus a SATA power adapter that can support two drives simultaneously.

The K8T Neo-FSR's three greenish DIMM slots support up to 2GB of DDR400/333/266/200. Its LOTES heatsink bracket and metal backing plate don't come attached to the board, but rather in a bag with the necessary bolts. The software bundle includes the by-now-familiar PC-cillin and Acrobat Reader, and the manual is very good.

There are just two SATA ports on this Neo, but they do get RAID 0 and 1 support through the VIA southbridge. Like the Epox board above, the K8T NEO-FSR comes with SATA RAID drivers on a handy diskette. Our particular board didn't have the optional Promise 20378 ATA/133 RAID or FireWire. However, few boards in this roundup had PATA RAID, and FireWire was always up in the next price bracket.

This Neo offers better AGP support than the Gigabyte above, handling 8X/4X/2X/1X without a qualm. However, MSI says that the Realtek 8110S-32 chip behind the integrated Gigabit Ethernet jack doesn't support 10/100Mbps connections. For its part, Realtek says that the 8110S-32 is fully backward compatible with

10/100Mbps Ethernet, so it's likely an implementation problem.

MSI packed four USB 2.0 ports into the backplane and made four more available as pins on the motherboard. A two-port bracket makes two of the latter useful. That bracket, called the D-Bracket 2, also holds four LEDs. These form a boot status and error code display visible from outside the case.

SPDIF users have a choice of outputs on the K8T Neo-FSR. There's an integrated RCA-style output, but the line out 1/8-inch jack can also carry SPDIF out. A Realtek ALC655 awakens your surround speakers with 5.1-channel audio.

This Neo can wake from a set alarm time, the mouse, or the keyboard. Built-in ports include a 9-pin serial, parallel, PS/2 mouse, and PS/2 keyboard connection. However, there's no provision for a MIDI/gameport.

The CoreCell chip near the DIMM slots is responsible for a whole host of ~~marketing terms~~ features. Among these are MSI's D.O.T. Dynamic Overclocking Technology, which automatically adjusts the CPU frequency per its current load. Cool-'n'Quiet in the BIOS adjusts the Athlon 64's fan speed. Finally, Speedster offers overclocking, LifePro prolongs the life of components and fans, and CoreCenter is a combination monitoring and overclocking utility.

This MSI had the second-best stock 3Dmark03 score, and was our third-best overclocker. It joins Albatron in the Three Year Warranty With Caveats Club, but note that the coverage period starts when the board was made, not purchased.

Who's Your Mama?

Our test results chart is, as we predicted, merely a formality. Sure, we found some variation in our boards' benchmark scores, but we're talking about a measly 2% overall delta in PCMark04 and just 0.7% in 3Dmark03. In other words, speed differences among otherwise similar boards should be your last consideration when you buy a new motherboard.

So what does matter? Stock performance may not vary much, but stable overclockability does. Also, one board may have a killer feature at a price the others can't touch.

Reliability and good tech support are paramount, which means that a manufacturer's reputation counts. However, this isn't a hard and fast rule. We've seen some erstwhile losers really turn their quality control around.

A great mix of features at a low price is exciting, but we would rather pay a few bucks more to get those features from a vendor with whom we've had better luck. Never skimp on your motherboard; it will affect everything you do with your system in the future.

With all that in mind, we'll call the Asus K8V-UAYZ your best bet. For $119, you'll get a three-year warranty, ATA/133 and SATA RAID, a solid track record, Gigabit Ethernet, Instant Music Lite, an SPDIF output jack, and top stock speeds. The $93 MSI K8T Neo-FSR, $111 Epox EP-8HDA3+, and $95 Gigabyte GA-K8VT800M also have strong points. CPU

by Marty Sems

Mobo Matchup

We did all testing with an Athlon 64 3000+ (2GHz, 512KB L2), 1GB (2 x 512MB) Kingston HyperX PC3200 DDR, a Gigabyte Radeon 9800XT with 256MB DDR, an 80GB Maxtor DiamondMax Plus 9 SATA hard drive (7,200rpm, 8MB cache), and a Lite-On 52X CD-ROM. Drivers, benchmarks, and BIOS versions were the most current available.

	Albatron K8X800 Pro	**Asus K8V-UAYZ**	**Chaintech SK8T800**	**Epox EP-8HDA3+**	**Gigabyte GA-K8VT800M**	**MSI K8T NEO-FSR**
Price	$98	$119	$77	$111	$95	$93
3Dmark03 (1600x1200x32)	6495	6510	6492	6487	6465	6504
PCMark04	4009	4054	3993	4010	3974	3978
CPU	3785	3774	3711	3724	3730	3738
Memory	3552	3562	3494	3531	3544	3545
Graphics	4441	4499	4527	4572	4524	4519
Hard drive	4416	4433	4437	4397	4387	4427
Halo Timedemo (1600x1200 x32), fps	26.7	27.07	26.89	26.84	27.47	26.77
Overclocking (CPU, FSB, voltage)	2.11GHz, 211MHz, 1.6V	2.15GHz, 215MHz, 1.4V	2.15GHz, 215MHz, 1.5V	2.17GHz, 217MHz, 1.5V	2.25GHz, 225MHz, 1.47V	2.16GHz, 216MHz, 1.5V
O/C increase (%)	5.5	7.5	7.5	8.5	12.5	8
Warranty	3 years labor, 1 year parts	3 years	1 year	2 years	3 years limited	3 years parts, 2 years labor

MY DDR CAN BEAT UP YOUR DDR

Memory Speeds Advance Faster Than Industry Standards

There are many very fast DDR memory modules on the market right now, but unfortunately for the average user, as of press time, JEDEC (Joint Electron Device Engineering Council) has only approved standards up to PC3200. However, with memory as fast as PC4400 currently available, the only real limit to running DDR faster than PC3200 is having the proper hardware and know-how. To the power modder, the full range of DDR is accessible.

Parts Selection

We tested the latest memory, ranging from PC3500 to a whopping PC4400 DDR. The only motherboards available that supported the FSB necessary to run PC4400 DDR at 550MHz were the Asus P4C800 Deluxe and P4C800-E. We chose the P4C800-E motherboard, which has generally received excellent reviews from other overclockers.

Just as important as the motherboard was the choice of processor. The 2.4GHz Pentium 4 has been around long enough to be fine-tuned and more stable than some of the newer CPUs we could have chosen. In addition, we noted that many others in online forums and overclocking publications have had excellent results overclocking the 2.4GHz P4. (This was necessary because as we increased the FSB to bring the memory to the proper frequency, we would also increase the processor's clock rate.)

At press time the fastest DDR SDRAM available was PC4400. We chose a selection of 512MB PC3500, PC3700, PC4000, PC4200, and PC4400 dual-channel DDR kits from five manufacturers: Corsair (www.corsair.com), GeIL (www.geilusa.com), Kingston (www.kingston.com), Mush-kin (www.mushkin.com), and OCZ (www.ocztechnology). We ordered our memory through retail outlets. The manufacturers had no idea these modules were for *PC Modder* magazine rather than for an average home user.

We did not include any DDR2 modules in our tests because very few modules were available at press time. With the release of DDR2-compatible chipsets, such as Intel's 915 on the horizon, expect *PC Modder* to complete a thorough line of DDR2 tests next time.

How We Tested

We adjusted a few settings in SiSoftware's Sandra 2004 to allow for more accurate benchmark scores. By default Sandra allows special instructions and buffering, two things which would have compromised the integrity of our results. We used Sandra's Bandwidth Benchmark Wizard to disable all MMX, SSE, SSE2, and Buffering/Block-Prefetch Benchmarks. As a result, our Sandra may seem low, but the results are a better reflection of the performance of the memory itself rather than special CPU instructions.

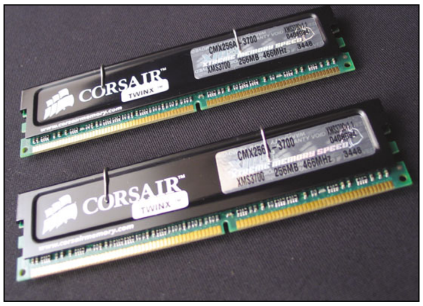
We first benchmarked the memory at its listed frequency by entering the BIOS and adjusting the FSB. Because no processor or motherboard officially supports the FSB necessary to run the non-JEDEC-approved PC3500 and faster DDR, every test we ran involved some degree of overclocking to achieve the memory's rated speed. Our goal was not to overclock as much as possible but to compare the memory's performance at its intended frequency (or as close to it as we could get). We encountered stability issues with exactly one-third of the modules we tested, so even basic benchmarking gave us insight into which DDR might be more suited to overclocking.

We started with the Auto setting for the Core Voltage. We then benchmarked the performance using Sandra 2004, recording the Integer ALU, Float FPU, and CAS Timing for each. If a system was unstable, we typically saw one of four things: on-screen video errors, a Sandra crash, an inability to launch Sandra, or an inability to load Windows. We treated each of these problems as an indication that we needed to make adjustments to stabilize the system. To ensure that overclocking the PCI bus did not cause display problems, we entered the BIOS and locked the PCI bus at 66.66/33.33.

When we encountered minor errors, such as display problems, we first tried to benchmark the system (making a note of the errors) before adjusting the voltage or frequency. Our efforts to stabilize systems involved first increasing the voltage until the system was stable. We then restored the Auto setting for voltage and lowered the FSB until the system was stable.

PC3700 DDR Tests

The contenders in the PC3700 category were from Corsair, GeIL, and Kingston. The GeIL DDR was rated with a slightly more aggressive tCL timing (2.5 as opposed to 3) than the Corsair and Kingston DDR. We would expect the lower tCL to correspond to higher performance, but possibly less system stability. We tested each of the



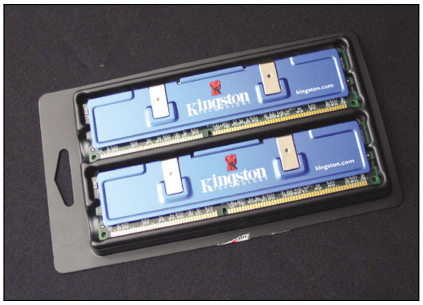
Corsair XMS3700 TWINX512-3700 PC3700

three pairs of memory modules to see if these predictions would hold up.

Corsair XMS3700 TWINX512-3700 PC3700. The first Corsair modules we tested were the pair in the XMS3700 TWINX512-3700 PC3700 kit. The dual-channel kit we tested came with black heatspreaders. You can also order the XMS3700 TWINX512-3700PT dual-channel kit, which has platinum heatspreaders. This memory is meant to operate at 466MHz and is rated with a 3-4-4-8 latency.

To test the PC3700 modules, we entered the BIOS and set the FSB to 233MHz (466MHz frequency divided by 2 = 233MHz). Windows loaded and Sandra 2004 ran its benchmarks without any difficulty. The Integer ALU score was 2524, and the Float FPU score was 2571. The CAS timings were 3-4-4-8, as expected.

GeIL Golden Dragon PC3700 466MHz Dual Channel DDR Kit. GeIL's Golden Dragon PC3700 466MHz Dual Channel DDR Kit was the only memory we tested that did not have a heatspreader. GeIL still presented the memory very attractively, however. The modules themselves are a golden yellow with shiny gold patterns and dragon illustrations on the circuit board. In addition, a red LED is built into each module in the pair. These LEDs light up when the system is running. Even without heatspreaders, this memory attracts plenty of attention through a case window. GeIL also provided interesting retail packaging for the Golden Dragon memory. The DDR came in a small, folding, cloth-covered book.


GeIL Ultra Platinum PC3500 433MHz Dual Channel DDR Kit

Without the sturdy heatspreaders that the other DDR pairs had, it was noticeably more difficult to insert the Golden Dragon PC3700 DDR into the DIMM slots. The real cause for concern, though, was whether the system would run stable without heatspreaders for the memory.

Although the system ran stable enough to run Sandra 2004, we did encounter problems with the Golden Dragon memory. Once again, we saw the dreaded on-screen distortion that we would normally associate with memory corruption. After running Sandra 2004 and receiving benchmark scores of 2496, 2546, and 2.5-4-4-8 for Integer ALU, Float FPU, and CAS timings, respectively, we increased the voltage from 1.5V to 1.525V and loaded Windows.

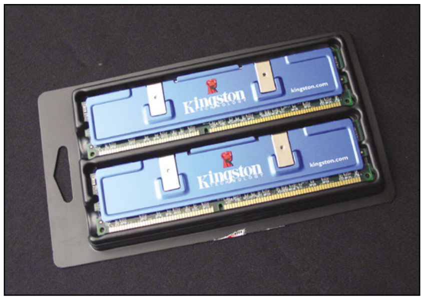
The increase in voltage corrected the memory-related problems that had presented themselves in the on-screen display errors. This time, Sandra returned improved scores of 2592 and 2604 for Integer ALU and Float FPU.

Next, we restored the voltage to the Auto setting of 1.5V and instead lowered the FSB. At 232MHz, the system was stable, and graphics displayed properly on screen. We ran Sandra and recorded scores of 2520 Integer ALU and 2575 Float FPU.

Our best result (2592:2604) came from increasing the voltage and leaving the FSB set at 233MHz. The lack of a heatspreader could have contributed to the stability issues, or the display problems could have been due to the lower CAS timing of 2.5tCL, which is more aggressive and could have led to some system instability. The other PC3700 we tested had a CAS timing of 3 tCL.

Kingston HyperX KHX3700K2/512 512MB Kit. Kingston's HyperX memory is designed for gamers and built for maximum compatibility with several chipsets popular with gamers and overclockers. We bought a HyperX KHX-3700K2/512 512MB Kit and ran it through Sandra's tests to see how it compared to similar PC3700 DDR by Corsair and GeIL.

Kingston's PC3700 memory came with blue heatspreaders and is rated at 2.6V with CAS timings of 3-4-4-8. The memory carries a lifetime warranty. We ran Sandra 2004 and found the system to be stable. The Integer ALU score was 2510, and the Float FPU score was 2559.


Kingston HyperX KHX3500AK2/512 512MB DDR Kit

PC3700 results. Despite some difficulty getting GeIL's PC3700 DDR to run stable, it provided the highest Sandra 2004 scores. Users should be aware, though, that the GeIL's Golden Dragon memory lacks heatspreaders and may take a bit more tweaking in order to run in a stable environment.

PC4000 DDR Tests

We had a streak of luck when we shopped for PC4000 DDR. All five manufacturers had PC4000 memory available at the time, so we could do a real comparison between them. Although the PC4000 forced us to push the FSB even further, we only had one DDR pair give us any difficulty. For the most part, the Asus P4C800-E board continued to convince us that it is the board for overclocking.

Corsair XMS4000 TWINX512-4000. The first PC4000 DDR we tested was the Corsair XMS4000 TWINX512-4000, a member of Corsair's TWINX family of DDR. The modules in this pair had black heatspreaders and were designed to operate at 500MHz and a latency of 3-4-4-8.

After setting the FSB to 250MHz, the system ran stable enough to load Windows. We ran Sandra 2004 and recorded the Integer ALU (2724) and Float FPU (2762). The CAS timings were 3-4-4-8, as expected.

GeIL Ultra Platinum PC4000 500MHz Dual Channel DDR Kit.

Next, we moved on to the GeIL PC4000 offering. This dual-channel kit, unlike the GeIL PC3700 kit, came with heatspreaders. The platinum copper heatspreaders attract fingerprints easily, so if you want to show off your system and its shiny memory, you'll want to be careful when handling the GeIL Ultra Platinum DDR modules. GeIL includes a lifetime warranty. Voltages of 2.6V to 3.1V are supported, and the memory's latency is rated at 2.5-4-4-7. A sturdy clear acrylic case with sliding cover protects the memory in shipping and storage. As with the other GeIL Ultra Platinum modules, this memory includes temperature-reading stickers on the heatspreader.

As with the Corsair PC4000 DDR, the GeIL PC4000 memory ran with the FSB set to 250MHz without any difficulty. Sandra returned scores of 2703 Integer ALU and 2750 Float FPU, a little bit slower than the Corsair memory, which was surprising because the GeIL memory actually had the more aggressive of the two CAS timings.

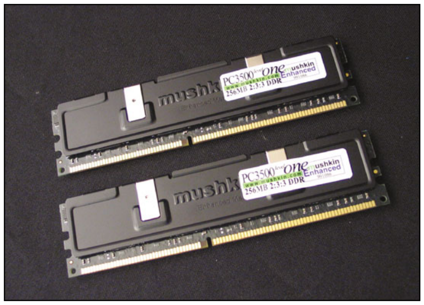
Kingston HyperX KHX4000K2/512 512MB Kit. Kingston's PC4000 memory was another member of the company's HyperX line of DDR. It features the trademark blue heatspreaders.

Just as we had problems with the display when using the Kingston PC3500 DDR, we once again ran into display difficulties with the Kingston PC4000 DDR. We were able to run Sandra despite the video errors and recorded scores of 2692 Integer ALU, 2748 Float FPU, and CAS timings of 3-4-4-8.

We began troubleshooting by leaving the FSB untouched and increasing the voltage from the default 1.5V to 1.525V. With the increased power, the system ran stable, and Sandra benchmarked the memory at 2760 Integer ALU and 2802 Float FPU.

We wanted to compare these results with the scores we would get from decreasing the FSB until the system stabilized. At 248MHz and 1.5V, our system was stable. We ran Sandra and noted the Integer ALU and Float FPU of 2702 and 2739, respectively. Clearly, in this case, we achieved the best results by increasing the voltage.

Mushkin 512MB Dual Pack PC-4000 DDR. We also tested Mushkin's 512MB Dual Pack PC4000 DDR, which supports 2.5V to 2.75V and comes with heatspreaders. The color of the heatspreaders varies, but our module came with royal purple-colored heatspreaders. This memory scored at 2716 Integer ALU and 2757 Float FPU. Although we ran the memory at its rated 500MHz (250MHz FSB x 2 = 500MHz), Sandra returned a CAS timing of 2.5-4-4-8. According to Mushkin's specs, at 500MHz this memory should have had a tCL of 3 rather than 2.5. The 2.5 is actually a more impressive latency score, however, so we did not object.


Mushkin 512MB PC3500 DDR Level 1 Dual Pack

OCZ Enhanced Latency DDR PC-4000 Dual Channel Gold. Up until this point, we had not benchmarked any of OCZ's memory. We were anxious to see how its DDR performed compared to Corsair's, GeIL's, Mushkin's, and Kingston's. In terms of stability, we were not disappointed. OCZ's PC4000 DDR ran perfectly at a 500MHz frequency. The memory modules in our kit featured gold-layered copper heatspreaders. Overclockers should take note that OCZ offers EVP (Extended Voltage Protection), which lets users take advantage of VDIMMs of 3.0V +/-5% without violating the terms of the lifetime warranty.

OCZ Enhanced Latency DDR PC-4000 Dual Channel Gold

After benchmarking the OCZ memory, we could see that only the Corsair and Kingston PC4000 DDR provided higher Sandra scores. OCZ's PC4000 weighed in with a 2723 Integer ALU, a 2744 Float FPU, and CAS timings of 2.5-4-4-8. Although this memory may work with other motherboards, OCZ designed it especially for boards based on Intel's i865 and i875 chipsets. You should get the most stability and best performance, then, with Intel i865/i875 boards.

PC4000 results. As with the PC3500 tests, Kingston failed to run stable at its intended frequency without some tweaking of the voltage settings in the BIOS. However, once again, after tweaking the system settings with the Kingston DDR, it took the crown for the best Sandra scores in its class. The Corsair and OCZ DDR modules, however, would be serious contenders in a battle to woo our credit cards into making a few DDR purchases. After all, there is something to be said for out-of-the-box stability at the rated frequency.

PC4200 DDR Tests

When we approached the PC4200 tests with our GeIL and OCZ modules, we knew that we would soon know if our 2.4GHz P4 processor was as overclock-friendly as some of the 2.4GHz that others had used with the Asus P4C800-E board. We entered the BIOS, upped the FSB setting to 266MHz, and got ready to test our two PC4200 dual-channel kits.

GeIL Ultra Platinum PC4200 533MHz Dual Channel DDR Kit. The GeIL Ultra Platinum PC4200 kit included GeIL's Ultra Platinum standard platinum copper heatspreaders with temperature thermometers. The memory was rated at CAS timings of

3-4-4-8 and supports 2.6V to 3.1V. A lifetime warranty is included.

Running at the intended 533MHz, the PC4200 returned Sandra scores of 2985 Integer ALU and 2994 Float FPU.

OCZ Enhanced Latency DDR PC-4200 Dual Channel. These memory modules included copper heatspreaders and were rated with CAS timings of 2.5-4-4-7. OCZ once again offers its EVP for its lifetime warranty, so you have room to up the voltage (up to 2.9V) before voiding your warranty. This memory is optimized for motherboards based on the Intel i865 and i875 chipsets.

Whereas the OCZ PC4000 DDR was very stable, we could not keep Sandra running with OCZ's PC4200 DDR installed and the FSB set at 266MHz. We increased the voltage to 1.525V and 1.5375V, but the system only became more unstable as we proceeded. In fact, with any voltage above 1.5V, we could not even load Windows. We entered the BIOS and set the voltage back to Auto (1.5V) and tried adjusting the FSB instead. At 264MHz, the system was stable. Sandra returned scores of 2915 Integer ALU, 2979 Float FPU, and 2.5-4-4-8 CAS.

PC4200 results. GeIL was the clear winner in the PC4200 competition. Its memory ran without making the system unstable, and despite having a tCL of 3 rather than 2.5 (as the OCZ memory did), the GeIL DDR still outperformed the OCZ DDR in the Sandra 2004 tests.

PC4400 DDR Tests

As of press time, PC4400 is still the fastest memory available for retail sale. We tested two PC4400 dual-channel modules, GeIL's Ultra Platinum PC4400 550MHz Dual Channel DDR Kit and OCZ's Enhanced Latency DDR PC-4400 Dual Channel Gold.

GeIL Ultra Platinum PC4400 550MHz Dual Channel DDR Kit. GeIL's PC4400 DDR has platinum copper heatspreaders and comes with a lifetime warranty. It is rated at 2.6V to 3.1V and CAS timings of 3-4-4-8. OCZ's Temperature Thermometers are built into the heatspreaders.

GeIL Ultra Platinum PC4400 550MHz Dual Channel DDR Kit

Until we reached the PC4400 tests, only the PC3700 DDR had proven problematic for GeIL. However, we had video errors with the GeIL PC4400 running at 550MHz (with the FSB set at 275MHz in the BIOS). We tried to run Sandra anyway, but although the application loaded, it crashed each time we tried to run the benchmarks. We increased the voltage, but the system became less stable and wouldn't even load Sandra.

We restored the voltage setting to Auto (1.5V) and lowered the FSB. At 274MHz, 273MHz, and 272MHz FSBs, Sandra once again loaded but still crashed when we tried to run the benchmarks. Finally, at 271MHz, the system was stable. We benchmarked the memory at this point, although the memory was actually running at 542MHz rather than its intended 550MHz. Integer ALU and Float FPU scores were 3089 and 3060, respectively.

OCZ Enhanced Latency DDR PC-4400 Dual Channel Gold. After the uphill battle with GeIL's PC4400 DDR, we were prepared to do plenty of tweaking in the BIOS to make OCZ's PC4400 memory work with our system. However, it was a pleasant and amazing surprise that the OCZ PC4400 presented no stability issues for our system at all.

After setting the FSB to 275MHz in the BIOS, we ran Sandra and recorded latency timings of 3-4-4-8 (as opposed to the 2.5-4-4-8 that we expected). The Integer ALU was 3053, and the Float FPU was 3078, both scores that were very comparable to the GeIL PC4400's scores.

Our OCZ PC4400 modules had gold-layered copper heatspreaders and came with EVP, providing more freedom within the terms of the lifetime warranty to increase the voltage, if your system isn't as stable at 550MHz as ours was.

PC4400 results. Both of these pairs of memory modules performed very well. The GeIL memory scored slightly higher in the Integer ALU mark and slightly lower in the Float FPU mark. Remember that the GeIL memory was actually underclocked at 542MHz. If we could have run it 550MHz, it would have certainly outperformed OCZ's PC4400. However, the fact of the matter is that the GeIL system was only stable at 542MHz, at which point both manufacturers' PC4400 DDR performed equally well. We still preferred OCZ's memory simply because OCZ seemed to have done more thorough stability testing and provided the EVP coverage.

Memory On The Move

In May, OCZ announced its Enhanced Latency DDR PC-4800 Dual Channel kit. We hoped it would be available in time for this issue, but it hasn't hit any store shelves or online retailers as of press time. This 600MHz DDR will be fast. Currently, the Asus P4C800 Deluxe and P4C800-E Deluxe (with 300MHz FSB support) are the only boards to support PC-4800. Although our OCZ PC4400 DDR worked fine without additional cooling, we would probably need more than the stock fan for PC4800.

After swapping and benchmarking all of the PC3500, PC3700, PC4000, PC4200, and PC4400 DDR we could find, one basic truth emerged: You can achieve impressive results with this memory, provided that your motherboard supports high FSB settings and that you have an overclock-friendly CPU. We were impressed that two-thirds of the memory modules ran without any stability issues using only stock cooling. This memory is already fast, and some of the modules hold great promise for performing at even greater frequencies. CPU

by Kylee Dickey

How The Manufacturers Compare

We benchmarked 15 memory modules that are not yet JEDEC (Joint Electron Device Engineering Council)-approved, overclocking our system as necessary to run the memory at the proper frequency (or as close as we could without encountering stability issues). The charts below compares the performance of Corsair, GeIL, Kingston, Mushkin, and OCZ memory of five types: PC3500, PC3700, PC4000, PC4200, and PC4400 DDR.

Company & Memory	**Testing Procedure**	**Integer ALU**	**Float FPU**	**CAS**	**FSB**	**Voltage**	**Notes**
PC3700 DDR							
Corsair XMS3700 TWINX512-3700 PC3700	Set FSB to 233MHz	2524	2571	3-4-4-8	233MHz	Auto (1.50V)	
GeIL Golden Dragon PC3700 466MHz Dual Channel DDR Kit	Set FSB to 233MHz	2496	2546	2.5-4-4-8	233MHz	Auto (1.50V)	Not stable. Images on screen that are normally associated with memory corruption. Locking PCI bus did not help.
	Increased voltage	2592	2604	2.5-4-4-8	233MHz	1.525V	Stable
	Lowered FSB	2520	2575	2.5-4-4-8	232MHz	Auto (1.50V)	Stable
Kingston HyperX KHX3700K2/512 512MB DDR Kit	Set FSB to 233MHz	2510	2559	3-4-4-8	233MHz	Auto (1.50V)	
PC4000 DDR							
Corsair XMS4000 TWINX512-4000 PC4000	Set FSB to 250MHz	2724	2762	3-4-4-8	250MHz	Auto (1.50V)	
GeIL Ultra Platinum PC4000 500MHz Dual Channel DDR Kit	Set FSB to 250MHz	2703	2750	2.5-4-4-8	250MHz	Auto (1.50V)	
Kingston HyperX KHX4000K2/512 512MB DDR Kit	Set FSB to 250MHz	2692	2748	3-4-4-8	250MHz	Auto (1.50V)	Not stable. Images on screen that are normally associated with memory corruption. Locking PCI bus did not help.
	Increased voltage	2760	2802	3-4-4-8	250MHz	1.525V	Stable
	Lowered FSB	2702	2739	3-4-4-8	248MHz	Auto (1.50V)	Stable
Mushkin 512MB Dual Pack PC4000 DDR	Set FSB to 250MHz	2716	2757	2.5-4-4-8	250MHz	Auto (1.50V)	
OCZ Enhanced Latency DDR PC-4000 Dual Channel Gold	Set FSB to 250MHz	2723	2744	2.5-4-4-8	250MHz	Auto (1.50V)	
PC4200 DDR							
GeIL Ultra Platinum PC4200 533MHz Dual Channel DDR Kit	Set FSB to 266MHz	2985	2994	3-4-4-8	266MHz	Auto (1.50V)	
OCZ Enhanced Latency DDR PC-4200	Set FSB to 266MHz	N/A	N/A	N/A	266MHz	Auto (1.50V)	Not stable. Windows loaded but Sandra crashed.
	Increased voltage	N/A	N/A	N/A	266MHz	1.525V	Not stable. Windows couldn't load.
	Increased voltage again	N/A	N/A	N/A	266MHz	1.5375V	Not stable. Windows couldn't load. Didn't increase voltage any more because system seemed to get more unstable rather than less unstable. Would have needed more aggressive cooling methods to continue with this approach.
Dual Channel	Lowered FSB	2915	2979	2.5-4-4-8	264MHz	Auto (1.50V)	Stable
PC4400 DDR							
GeIL Ultra Platinum PC4400 550MHz Dual Channel	Set FSB to 275MHz	N/A	N/A	N/A	275MHz	Auto (1.50V)	Not stable. Images on screen that are normally associated with memory corruption. Sandra wouldn’t run
	Increased voltage	N/A	N/A	N/A	275MHz	1.5375V	Not stable. Sandra wouldn't load.
	Lowered FSB	N/A	N/A	N/A	273MHz	Auto (1.50V)	Not stable. Sandra loaded but crashed.
DDR Kit	Lowered FSB	3089	3060	3-4-4-8	271MHz	Auto (1.50V)	Stable
OCZ Enhanced Latency DDR PC-4400 Dual Channel Gold	Set FSB to 275MHz	3053	3078	3-4-4-8	275MHz	Auto (1.50V)	

For our full testing results, including our PC3500 tests, check out www.cpumag.com/modder2/ramroundup.

Method With Best Result	Best Result (Integer ALU : Float FPU)	Manufacturer With Best Score	Additional Notes About Results
N/A	2524:2571	GeIL, at 2592:2604	We had more difficulty maintaining a stable system with the GeIL memory; however, we also achieved the best results. Both of these facts are likely due to the GeIL DDR's more aggressive 2.5 tCL timing, as opposed to the Corsair and Kingston DDR's more passive 3 tCL timing.
233MHz FSB, 1.525V	2592:2604		
N/A	2510:2559		
N/A	2724:2762	Kingston, at 2760:2802	It is surprising that we needed to adjust the Kingston DDR because, unlike the Mushkin and OCZ PC4000 DDR, the Kingston memory had a more relaxed tCL timing.
N/A	2703:2750		
250MHz FSB, 1.525V	2760:2802		
N/A	2716:2757		
N/A	2723:2744		
N/A	2985:2994	GeIL, at 2985:2994	GeIL had the more impressive Sandra scores, even though it used a more passive tCL timing. The OCZ PC4200 DDR was simply too unstable in this system.
264MHz FSB, 1.5V (only settings at which the system was stable)	2915:2979		
271MHz FSB, 1.5V (only settings at which the system was stable	3089:3060	GeIL, at 3089:3060	Although the GeIL PC4400 DDR had the best benchmarks, our system did not run at all stable with this memory. The OCZ memory would probably be a safer dual-channel kit for long-term usage. However, it is impressive that even when underclocked, the GeIL PC4400 DDR still beat out the OCZ DDR that was running at its intended frequency.
N/A	3053:3078		

CLOCKING CORNER

Push That New CPU To The Limit

You've spent thousands of dollars on a brand-new Pentium 4 system and can't wait to watch it tear through your data. Only problem is, it's not living up to the hype. A possible solution that won't cost you another arm and leg is to overclock your system.

Overclocking is a procedure that involves changing the speed of your CPU by one of two methods. The FSB speed and the multiplier determine the clock speed of your CPU. For instance, a 600MHz CPU can have an FSB of 66MHz and a multiplier of 9: 9 x 66MHz = 600MHz. To overclock your system, you will have to change either the FSB speed or the multiplier. You can change these options by either modifying the BIOS of your computer or, if this is not an option, by moving bridges on your hardware to change the voltages supplied to your components.

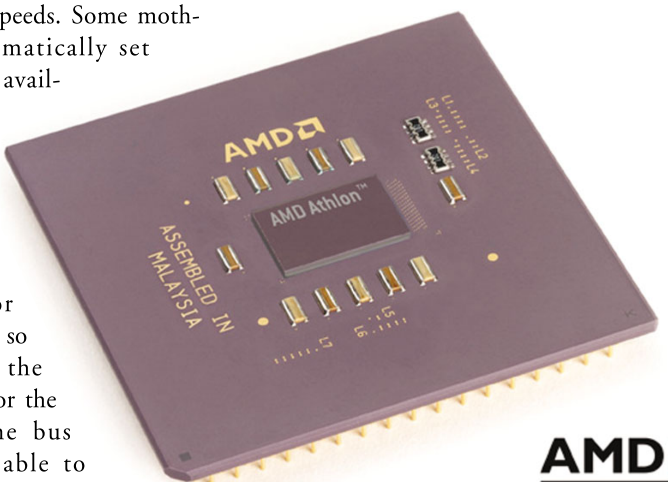
WARNING: Overclocking is not a procedure that you should undertake lightly. If you're not sure you can handle this, don't try. Before you start, you should back up all of your data and take careful notes of default settings in case something goes wrong. Aside from that, best of luck and enjoy.

Overclocking Basics

Changing the multiplier is often difficult. For instance, on most Intel CPUs, the multiplier cannot be changed. However, AMD does produce CPUs that have a multiplier you can modify. You will have to check the specs on your specific motherboard on an AMD product sheet to see if your multiplier can be changed. If you cannot change the multiplier, you will have to change the FSB speed. One trick I found to change the overclockable Athlon CPU is called, simply, "The Pencil Trick."

To change the bridges on your AMD motherboard, get a 0.5mm mechanical pencil with graphite lead and a business card. Remove the processor from your system and locate the L1 bridges on the CPU, which are those responsible for locking out the multiplier. The bridges are the same for both the Athlon and Duron processors. Separate the bridges using the business card and, working from left to right, rub the pencil back and forth across the bridges until the normal gold color is gone and the bridges are black. It sounds outrageous, but the graphite in the pencil is ideal for reconnecting the leads to conduct electricity across the bridge. Reinstall your chipset, and your motherboard is ready for overclocking.

If you've got a motherboard that will allow you to change the FSB speed, there are steps of frequencies to allow you to increase the speed of the CPU to its maximum. Most boards will jump from 75MHz to 83MHz and 90MHz or higher. Because the PCI and AGP bus speeds are directly related to the FSB speed by a different multiplier, you will also need to keep track of their speeds. Some motherboards will automatically set these to the closest available speed to the normal specs: 33MHz PCI bus and 66MHz AGP bus. Most of today's CPUs can handle a 100MHz or 133MHz FSB speed, so that if you change the multiplier jumpers for the AGP and PCI, the bus speeds should be able to adjust accordingly.



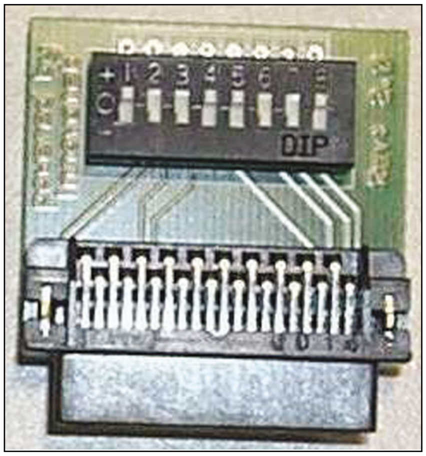
The Athlon from AMD is generally more overclock-friendly than its Intel counterparts.

Memory bus speeds are also clocked off of the FSB. Often, the FSB speed and the memory bus speed will be the same, and there is no way to change it. Some boards will allow a plus or minus 33MHz alteration, but you will have to check your board specs to determine if this is the case for you. If your board will allow this change and you are running a 100MHz FSB, you can bump your memory to 133MHz without problems. You should get the highest quality memory you can. For serious overclocking, you will want to get PC150 memory, which is memory that runs at 150MHz. Most memory can handle slightly higher speeds than what it is rated at. For example, PC100 memory can run at 110MHz, PC133 can run at 140MHz, etc. PC133 is the minimum you should use.

Now, I'll go into specifics on overclocking a couple of processors you might want to try out: the AMD Athlon and the Intel Pentium 4.

Overclocking An AMD Processor

The Athlon is a great overclocker. It is well-balanced, and its pipeline structure is built for high clock speeds. If you want to increase the FSB, you will need a Slot A motherboard like the ASUS K7M or the ASUS K7V that will allow you to adjust the FSB. These boards run at 100MHz, so, for example, a 7.5 multiplier will give you a



If you're into risk, you can buy or build an overclocking device to attach to the Athlon PCB.

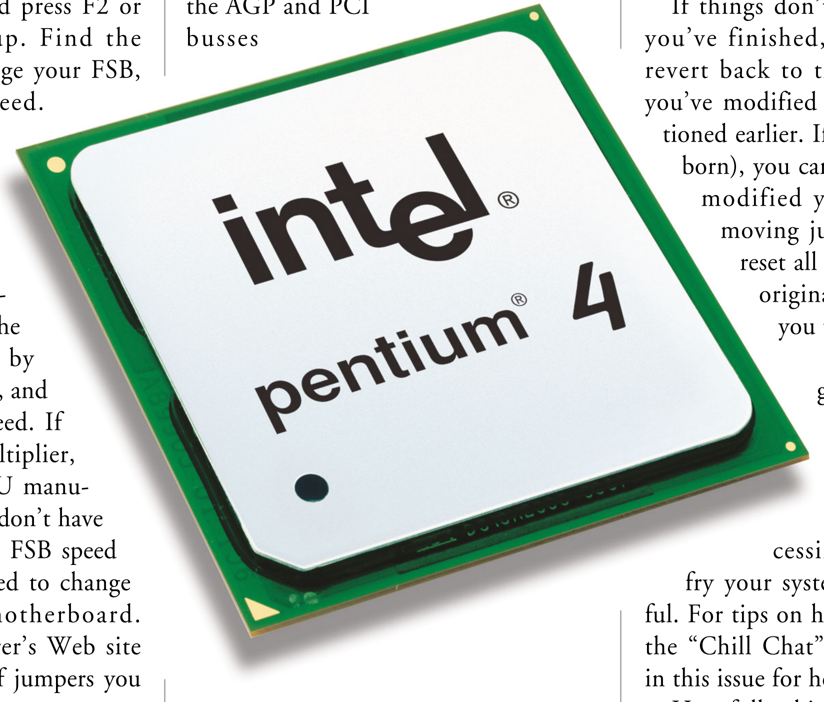
750MHz CPU. Once you have the board set up, all you have to do is change the FSB speed in the BIOS. If it doesn't work, the BIOS will reset to default values after a reboot.

To change the FSB value in the BIOS, reboot your computer and press F2 or DELETE to enter Setup. Find the option that lets you change your FSB, system bus, or clock speed. They should all be the same: between 66MHz and 133MHz. Increase your speed, keeping the capability of your RAM and motherboard in mind. Multiply the new value for FSB speed by your computer's multiplier, and this is your new CPU speed. If you don't know your multiplier, you should check the CPU manufacturer's Web site. If you don't have the option to change your FSB speed in the BIOS, you will need to change the jumpers on the motherboard. Checking the manufacturer's Web site will tell you which type of jumpers you will need to change.

If you're not going to change the FSB, you can change the multiplier. This is more difficult, but it can be done if you're feeling brave and know your way around a PCB and electronics components. In order to change the multiplier, you need to remove the plastic housing of the Athlon module and attach an overclocking device to the Athlon PCB. After you've got the box open and the device attached, you can change the multiplier from 5.0X to 10.5X by flipping a few switches. You can purchase an overclocking device from a local supply store or an online shop, or you can make one yourself using instructions available over the Internet.

Overclocking An Intel Processor

If you want to overclock your Intel CPU, you will have to choose your motherboard carefully, as there are only a few boards that will support overclocking. If you are overclocking a Pentium 4, you will also need a motherboard that will allow you to lock the bus speeds of the AGP and PCI buses because Pentium 4 processors are multiplier-locked. This means that the only way you can overclock a Pentium 4 is to modify the bus speed. With the AGP and PCI busses locked, the only thing you are overclocking is the CPU and memory, but you can even modify or slow down the bus speed of the memory on some boards, so you should only overclock the CPU. Use the method discussed above for AMD overclocking using the BIOS or the jumpers.



Overclocking an Intel CPU isn't easy, but it can be done.

After Your Procedure

Once you've made your modifications, you will need to determine system stability. Normally, if you reboot your system after your mods without problems like failure to start, blue screens, or unexplained restarts, you have done it right. Another way to tell would be to run a high-impact software package or 3D video game. If it performs as it should, you're probably OK. If you're paranoid like me, you might want to get a benchmark software package available over the Internet or at your local software supplier (also, check out "Essential Overclocking Utilities" on page 25).

Final Notes

If things don't work out right once you've finished, your system should revert back to the default settings if you've modified your BIOS as I mentioned earlier. If you're brave (or stubborn), you can try it again. If you've modified your motherboard by moving jumpers, you'll have to reset all of the jumpers to their original positions; hopefully you took notes.

Finally, once you've got all of that extra power, you're going to have another problem: heat. All that extra processing power is going to fry your system if you're not careful. For tips on heat removal, check out the "Chill Chat" column on page 158 in this issue for help.

Hopefully this has, at the very least, given you a peek into the world of overclocking your system. It's by no means an end-all of what's possible, but I hope it's helped. CPU

by David Miller

HEATSINK HEAVEN

The Right Product Will Save Your CPU From A Fiery Hell

Complex watercooling, peltier, and phase-change systems are all the rage, but heatsinks are still at the heart of most CPU cooling systems. That explains why computer component companies continue to pour money into heatsink research and development and why there are so many users willing to invest their limited computing budgets into a new heatsink—they know there might always be a heatsink that's just a *little* better than their current model, and not every user wants to expend the time or money to install a more complicated form of chip cooling.

But before you buy a new heatsink, it helps to have an idea of how well it will work. That's where we can help. We know you don't have budget to test and dismiss a dozen heatsinks before you find the one that's best for your CPU, but we do, so we ordered a pile of these products, everything from inexpensive aluminum extrusions to coppery monstrosities that barely fit inside our PC case.

Heatsink Hopes

Manufacturers design heatsinks to accommodate varying purposes, from keeping the heat off of a relatively cool Pentium III to dissipating the boiling temperatures of an overclocked Athlon 64. To find the appropriate heatsink to suit your purposes, you need to start with a basic understanding of heatsink construction.

CPU heatsinks fall into two broad categories: active and passive. Passive heatsinks are pretty rare even in heavily modded home PCs because they use a heatsink and nothing else for cooling.

Active heatsinks integrate the use of a fan, which cools the heatsink and allows the metal to absorb more heat from the CPU. This concept helps the heatsink transfer heat at a fast rate, preventing the CPU from exceeding optimal operating temperatures.

Both heatsink types are usually made from either copper or aluminum. Copper is heavier and more expensive but transfers heat more efficiently than aluminum. Many heatsinks combine both aluminum and copper, resulting in a product that works better than an aluminum heatsink but with significant cost savings.

Heatsink designs. Manufacturers produce folded-fin, bonded-fin, and cold-forged heatsinks and even heatsinks that use heatpipes, which are liquid-filled pipes that can help speed up heat transfer. All of these heatsink designs require special manufacturing techniques, but the most common heatsink creation methods involve extruded aluminum or machined copper.

Traditional aluminum heatsinks are almost always extruded, which means that the manufacturer forces a hunk of metal through a die to create fins. Those fins are usually rectangular, long, and skinny, all good traits for conducting heat to the surrounding air. The manufacturing process itself is automated and produces many heatsinks quickly, but these heatsinks have limited fin densities and heights.

Copper is denser and more difficult to work with, so heatsink makers use a machining technique to create fins. This process is more expensive than the extrusion technique, another reason copper heatsinks cost more than their aluminum brethren. To help you get an idea of performance differences, we tested numerous models of both heatsink types.

How We Tested

Of the nearly 20 heatsinks we tested, many were designed for only Intel socket 478 CPUs, and others were made specifically for AMD socket A CPUs. A few heatsinks included brackets that helped us switch them back and forth between AMD and Intel CPUs.

After we applied a fresh coat of thermal grease to each heatsink, we started up the PC, let it run for 10 minutes, and then recorded five temperatures. We took four of the readings from the temperature probes connected to a MacPower Digital Doc. We placed three of the probes between the fins of the heatsink, and we taped the fourth sensor so that it hovered above the heatsink fan. We also recorded temperatures using Motherboard Monitor, a program that uses your mobo's onboard sensors to track heat levels.

Once we recorded these initial temperatures, we made the situation more difficult for our test products. We ran PCMark04 on each CPU to see how each heatsink would respond to the added heat stress and then took notes on the higher temps we encountered.

Test disclaimers. We'll offer a few disclaimers before we reel off our heatsink test results. Heatsink effectiveness is fairly difficult to gauge for a couple of reasons. One, every heatsink, even those that are the same make and model, are different, thanks to manufacturing processes that leave microscopic ridges on the bottom surface of every heatsink and minor performance variations, as you read in "A Fine Grind," on page 140. Second, positioning the temperature gauges used to track heat levels is an important variable, but one that's also difficult to master because CPU makers acknowledge that their chips don't distribute heat evenly; meaning, of course, that the left side of a heatsink may end up a little hotter than the right. Finally, although Motherboard Monitor is a very handy utility, it's also notorious for reporting varying temperatures. However, we felt that this program did offer a general idea of how hot or cool our CPU ran from one heatsink to the next because switching heatsinks really changed temperature levels.

"Testing of heatsink effectiveness is a big topic and as varied as the number of people operating test labs," says Chris Soule, director of engineering at Thermshield (www.thermshield.com), a company that makes heatsinks for servers, workstations, and PCs. Soule, who has 15 years testing experience, says that he places a thermocouple near the heat input area (by the CPU) and another in the air nearby, which gives the tester a reference point. Soule says that for very accurate testing, you should use an anemometer to measure air velocity, a power meter to measure volts and amps, "and depending on power levels, there may also be a need to measure the power factor and correct for that." Sound extreme? It is, and Soule stresses that heatsink testing really is a science in and of itself.

The Reviews

Undeterred, we continued our testing to see what sort of numbers our homebrewed experiment would yield. Our rough readings should give you an idea of the performance you can expect from these products.

We reserved compliments for heatsinks with the most desirable traits. Ideally, heatsinks would become warmer because they were absorbing and dispersing more heat, but the CPU's Motherboard Monitor temperature would rise very little.

We also considered each heatsink's overall ease of use, aesthetic appeal and visual "wow" factor, and, in the case of some products, the quality of printed instructions. Heatsinks that looked like John Deere tractor engine parts and needed finger-fumbling mounting brackets got a less than enthusiastic response from us, while easy-to-use products that combine good looks and excellent cooling received two thumbs up.

Dr. Thermal TI-8639L

We paid: $23
Available at:
www.xpcgear.com
www.azzo.com

The Dr. Thermal TI-8639L has an ultra-simple but effective design, incorporating spiral-shaped aluminum fins melded to a copper core. This helps cut down on weight—the whole unit weighs only 364 grams—and, paired with the included 3,800rpm fan, provides good cooling capability.

It will only take you a minute to attach this Dr. Thermal product to your socket 478 motherboard, as it uses the same four-pronged clip that fits over your stock Intel heatsink. The fit is tight and very solid, and with a good coating of the included thermal grease, you won't have to worry about making consistent contact with the CPU's surface.

The TI-8639L's easy mounting system scored points with us, and the spiral fin pattern is mesmerizing, even after you attach the fan. The fan itself is nothing fancy, and we didn't like the fact that there was no grill to protect against in-case snags, but it's nice that you can replace the fan with a different model if you prefer.

Our impression of this product was that it's a slightly larger and nicer-looking version of Intel's stock heatsink. When you check out our "The Hot Get Cooler" chart of temperature readings, you'll see that this heatsink isn't all that effective, and because of this, we didn't think the TI-8639L was a very exciting product.

Zalman CNPS5500-Cu

We paid: $39
Available at:
www.computerhq.com
www.sharkacomputers.com

Zalman's CNPS5500-Cu isn't fancy; it's just one big hunk of copper that easily handles the heat-dissipating needs of a P4 running up to 2.5GHz, though we're sure this 540-gram monster could probably handle hotter chips. If you're using a slightly slower CPU, you'll have no cooling problems at all and will probably cut down on PC noise.

That's because the heatsink comes with a temperature-detection system that increases or decreases fan speed according to the heat levels of your CPU. At lower heat levels, the CNPS5500-Cu goes into Silent mode, and fan noise is inaudible.

In spite of this heatsink's heft, you don't need to remove the motherboard for a lengthy installation procedure. You center the heatsink over the stock clips on the motherboard and press down, and the plastic clips snap solidly into place. Then you can connect the fan directly to your motherboard or use the pass-through fan controller connector if you want to use the temperature monitoring system.

Removing this heatsink is a chore. You have to press down on the fan and then force the retention clips inward, and doing so takes significant strength. In the end, we had to remove our graphics card and enlist two people to pry this sucker loose. As far as looks go, as they say in "South Park," "There's nothing to see here." And the unit's large dimensions (it's 73mm tall) mean less room for other in-case components. Plus, as you'll see in our chart, the Zalman's average performance didn't seem to justify its higher than average price. Copper gets better than this Zalman.

Speeze 9T370B1M3

We paid: $25
Available at:
www.tigerdirect.com
www.newegg.com

For budget-conscious copper cooling, we checked out the Speeze 9T370B1M3, a high-quality, copper-based heatsink with a low price. Right out of the box, it's easy to see that Speeze prides itself on offering high-quality products, as the fan wires are shielded and the bottom of the heatsink has a preapplied layer of thermal grease.

The 3-watt heatsink measures 37mm high x 69.9mm wide x 83mm deep and comes with a 70mm 3,700rpm fan with a 28CFM rating. Speeze recommends this model for P4 and Celeron chips running at 3.2GHz or slower.

Installing the heatsink was quick and painless. Speeze includes two metal retention clips that snap directly into your motherboard's stock bracket, so you'll finish this job in about a minute. Unlike some other clips in this roundup, Speeze's clips make it easy to remove the heatsink, too.

With its relatively low profile and reasonable weight, this heatsink would be a good choice for users who have crowded case interiors, but only if there's no intense overclocking involved. Our Speeze model consistently ran hot and also let the CPU get warmer than most other heatsinks in our tests, topping out at 45 degrees Celsius when we started benchmarking. This one is best reserved for users who simply want something jazzier than their stock heatsink and don't want to spend a lot of money to get there.

Vantec CopperX

We paid: $30
Available at:
www.svc.com
www.xpcgear.com

The CopperX from Vantec has high-density, solid copper fins bonded to a hefty copper base. Though it tips the scales at nearly 540 grams, the CopperX's measures only about 60mm high. The 4,000rpm 70mm fan is 15mm tall, comes complete with a metal grill, and pushes air at 33CFM.

From the top and sides, this Vantec product looks like an average heatsink. When you get a glimpse of the bottom, though, prepare to be blown away. Though it's not quite slick to the touch, the near mirror-like finish will make you think twice before you attempt any sort of lapping procedure. We were almost sad to subject this beautiful finish to the layer of thermal grease on our CPU. As it turns out, we were comforted by Vantec's retention clips, which are things of beauty, too. These springy metal clips fasten directly to a stock 478 bracket for a three-second installation.

Performance wasn't as nice as the breathtaking design. We logged a Motherboard Monitor temperature of 45 C, one of the higher numbers in our test. Still, the knockout looks and relatively small size of this heatsink convinced us it's fine for cramped quarters and minimal overclocking.

Cooler Master Jet 4

We paid: $34
Available at:
www.zipzoomfly.com
www.frozencpu.com

For sheer visual impact, few heatsinks can beat the Jet 4, a copper heatsink matched to a blower fan that looks like a jet engine. It's not as cheesy as it first sounds, but only because Cooler Master went all out with the special effects, including a chrome-like finish, black blower interior, and red and white LEDs to simulate the look of a real aircraft.

The blower fan is louder than the traditional fans on our other heatsinks, but Cooler Master says the blower is superior because it funnels air straight down into the heatsink's center, supposedly preventing a dead spot you'd get with regular fans. You have a lot of control over fan functionality, as you can place the fan speed knob in either an expansion slot or in a 3.5-inch drive bay and, with a twirl, change speeds from 1,900rpms to 3,500rpms. That fun fan adds to the Jet 4's overall weight, which is a motherboard-mashing 700 grams, and the height is an incredible 140mm, meaning you definitely won't be using this particular model in a small-form-factor case.

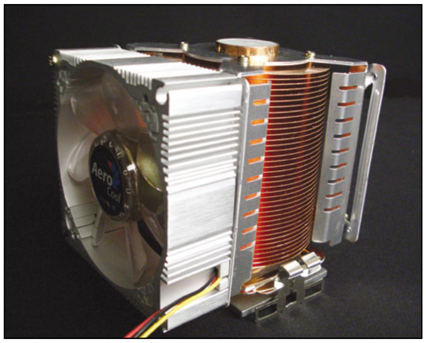
In a regular case, though, the Jet 4 provides substantial cooling, as Motherboard Monitor reported an average at-work temperature of 40 C. That's plenty cool for airport-obsessed modders who don't care how much space their heatsink consumes.

AeroCool Deep Impact DP-102

We paid: $55
Available at:
www.xoxide.com
www.frozencpu.com

When we shelled out nearly 60 bucks for the Deep Impact heatsink, we expected awesome cooling, but we certainly didn't expect the magic tricks we encountered. Yup, that's right, attach this heatsink to your CPU socket and *POOF*, your computer will magically stop working.

We don't know whether it was this heatsink's 580-gram heft or not-quite-big-enough circular copper CPU plate, but Deep Impact gave us fits. By the time we got it working (two hours after beginning the installation), we had encountered more weird boot-up problems and nervous PC tics than we could've ever imagined, and in the case of our Intel CPU, the only way to



successfully boot was to leave the motherboard flat on a table with only two screws securing the heatsink.

In spite of those problems, there's no denying the appeal of this heatsink's outrageous design, which includes a cylindrical heatpipe encircled by 36 copper fins, and not one, but two 80mm fans. The whole contraption swallows a ton of case space, thanks in part to its 100mm height, and with many motherboards, you might not be able to attach more than one fan.

The setup is visually striking, and our results showed that this AeroCool works better than stock heatsinks. Our Deep Impact kept both the Intel and AMD CPUs at stable temperatures, and it performed marginally better when we paired it with our Pentium 4, possibly because the mobo was resting outside the case. Idling temperatures were very cool—approximately room temperature—and work temperatures maxed out at 40 C. For modders who want to impress with size and have space to spare, the Deep Impact is about as high (and cool-looking) as heatsinks get, but be prepared for installation frustrations.

Scythe NCU-1000 Heatlane Zen

We paid: $59
Available at:
www.frozencpu.com
www.3dcool.com

Today's hot-running Pentium 4 CPUs attempt seppuku when users try to operate them without a heatsink fan, unless you can find a feasible passive heatsink such as the Scythe NCU-1000 Heatlane Zen. This very tall (143mm) and very wide (108mm) heatsink uses a system of fluid-filled fins to dissipate heat in a hurry, and from what we saw, this concept seems to work.

The Zen's total weight is a significant 615 grams. However, most of that heft is due to the heavy copper plate that covers the CPU, while the towering arrangement of fins is lightweight and won't cause any funny motherboard-flexing problems. That's not to say you won't run into problems with interior space logistics. The Zen's huge body didn't interfere at all with motherboard components, but it's easy to see that in a component-stuffed case, this product will only add to overcrowding.

To install this heatsink, we uninstalled our motherboard, slapped the Zen's rubber insulation pad and bracket to the mobo's backside, and screwed the heatsink snug against the CPU. There is one installation catch—you have to make sure the heatsink's fins run perpendicular to the floor so that the hot air in the fins can naturally rise up and away.

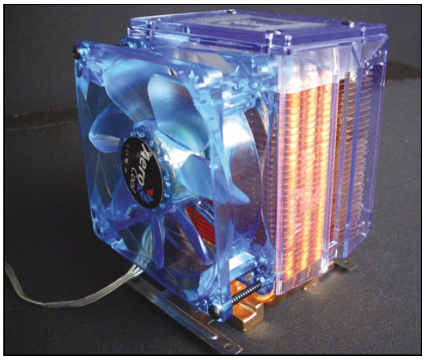
Our tests demonstrated that this works, but not as well as a heatsink that incorporates a zippy fan. The Zen had the highest temperatures at idle (42 C) and the second highest at work (49 C). Our results lead us to believe that this heatsink is probably inappropriate for serious overclockers, but for average users who will do anything to make their systems quieter, there are few alternatives to this Scythe.

AeroCool High Tower HT-101

We paid: $59
Available at:
www.zipzoomfly.com
www.frozencpu.com

Like its Deep Impact CPU cooler, AeroCool's High Tower HT-101 is an oversized heatsink with exciting technologies inside. Fortunately, we had much better success with the High Tower than with the exasperating Deep Impact.

This is another all-copper heatsink, but it uses three 6mm heatpipes to transfer heat to 31 vertically stacked copper fins. Designed for AMD XP 3600+ and P4 3.6GHz (and faster) CPUs, the HT-101 comes with one 80mm fan but can accommodate two 70mm or 80mm fans for added airflow. Adding a fan might not be a bad idea, as the included fan is a 2,500rpm model, but beware of space constraints. This monster is nearly 110mm tall and really doesn't need to be any bigger than it already is.



If you're into decorating your PC with lights, you will like this heatsink's plastic frame, which glows blue under a blacklight. Its massive amounts of copper are also plainly evident when you use only one fan, and all that penny-colored metal is sure to impress your aluminum-fixated friends, and they'll be even more jealous when they see the full-color instructions that help make installation simple.

The heatsink's cooling power, however, is less impressive. This heatsink's results included temperature spikes as high as 69 C, and Motherboard Monitor consistently tracked temperatures in the 50s, higher than the passively cooled Zen. If we really wanted a sky-high AeroCool product, we'd stick with the Deep Impact.

Scythe Kamakaze

We paid: $34
Available at:
www.directron.com
www.performance-pcs.com

The product name is misspelled on every retail Web site, and even on the product box itself, which is adorned with more Taiwanese than English, yet that's no reason to dismiss the Scythe Kamakaze outright. Or is it?

Poor translations hindered this product's ease of use. Installation instructions were difficult to read, and the diagrams (one each for Intel and AMD sockets) were less than fully explanatory, but muddle your way through, and you'll see that this Scythe product comes preconfigured for an AMD socket A, so for a socket 478, you have to play with tiny screws and an unwieldy bracket before you can begin installation in earnest. Once you click a new bracket into place on the motherboard, it's easy to snap the Kamakaze into place, and the fit is secure.

The Kamakaze weighs nearly 700 grams and stands 90mm tall. It comes with a grill-less 80mm fan that will beckon to every cable in your box, but the fan does have redeeming traits, most notably an expansion-slot-mounted speed knob that lets you adjust rpms from 1,300 to 3,400.

This heatsink is made of aluminum, but instead of fins, Scythe incorporated long, jagged pins (about 500 of them) that make for a turbulent airflow and thus maximize cooling. The overall look is a little awkward, and due to the messy weld points on the edges of the metal jacket, this potentially very cool heatsink loses big points on aesthetics.

After we finished testing, we decided we wouldn't buy this heatsink for either an Intel or AMD CPU. The idling temperatures were higher than average on both chips, in some cases approaching the working temperatures of other heatsinks we tried. When we turned the heat up a little, our CPU temps rose to 46 C, which is fine for general purposes but not enough to sway the jury in the Kamakaze's favor.

Gigabyte Cooler Pro GH-PCU21-VG

We paid: $45
Available at:
www.newegg.com
www.pcdirectsource.com

The Gigabyte Cooler Pro is one of the freakiest and most effective heatsinks we tested. You probably won't find anything more eye-catching that this blue-tinged alien; nothing else in our roundup came close to grabbing our attention like the Gigabyte's glowing blue top and copper fins, which stand on the four "legs" and CPU block that actually make up a heatpipe cooling system.

There's precious little making up the copper block that makes contact with your CPU. Apparently, that thin layer is enough to whisk heat away via the heatpipes and into the circular fin pattern, which—like the Cooler Master Jet 4—contains a blower fan instead of a traditional finned fan. This blower works at speeds from 2,000rpms to 4,000rpms, and you can install a fan speed control knob, which slips into either a floppy diskette drive bay or an expansion card slot.

The heatsink and fan weigh only about 460 grams, which is very light considering the product's 93mm height. This heatsink's wacky design shouldn't cause too many difficulties with space, but there are a couple of flanges at the base that may interfere with motherboard components.

This is an adaptable heatsink with a user-friendly clip system. It not only works with Pentium 4 3.2GHz and faster CPUs, but also with AMD's super-fast processors, including the Athlon 64, and for each socket type, Gigabyte helpfully included easy-to-use fasteners that make installation a pleasure.

Most of our cool-looking heatsinks weren't top performers, but the Copper Pro proved its worth on our hot Pentium 4, logging very low at-work temps of 33 C and 37 C from our Digital Doc and Motherboard Monitor, respectively. The heatsink returned higher numbers when we used it with our Athlon, but the maximum recorded temperature was only 43 C. For modders and overclockers who like flashiness, the Cooler Pro is worth the dough.

Alpha PAL8942

We paid: $39
Available at:
www.frozencpu.com
www.performance-pcs.com

Alpha's PAL8942 is a forged heatsink with a copper plate that sprouts hexagonal aluminum pins. These pins are anodized black, which offers the Dark Side aesthetic appeal but has no effect on performance. The copper base is a thing of beauty, with a glossy, brushed finish that won't require lapping unless you're obsessive about smoothness.

Alpha did not include a fan with this heatsink, as the company prefers to leave this option to the reseller. Our vendor didn't include a fan, so we opted for a standard 80mm 4,800rpm fan, and whatever fan you choose will add to this model's 44mm height.

When you see the baggies of screws, nuts, and other hardware, you intuitively know installation is going to require some work, and because the PAL8942 makes no use of stock heatsink brackets, you end up using

screws and springs to mount the device directly to the motherboard. You do have to remove the mobo for this project, but thanks to the clear instructions, this job shouldn't take you more than a few minutes. Unlike a few other heatsinks we've seen that screw into the motherboard, this one uses compression screws so you know exactly how much pressure you can apply without causing damage.

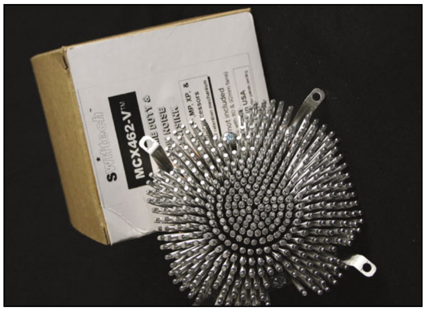
This Alpha's understated looks belied its superb performance. At work, our Intel CPU edged upwards to only 36 C, cooler than with any other heatsink we tested. Its relatively small size and effectiveness proved to us that this heatsink is perfect for serious users who like good looks in a small heatsink, yet still need better-than-average cooling power.

Swiftech MCX462-V

We paid: $52
Available at:
www.sidewindercomputers.com
www.coolerguys.com

Swiftech's heatsinks are renowned for their off-the-wall designs and top-notch performance, and one of the company's most highly touted models is the MCX462-V, which uses a half-inch thick copper baseplate matched to 390 patented Helicoid aluminum pins. These pins are arranged in a circular pattern and have rough edges to increase turbulence at low fan speeds, which optimize cooling while helping your system stay quiet.

Speaking of fans, you don't get one with this heatsink, but you do receive hardware that lets you attach the 80mm or 92mm fan of your choice. We opted for a Vantec Tornado, a gutsy fan that spins at 4,800rpm and moves air at 119CFM. That consumed a lot of space, but the heatsink alone is actually less than 40mm tall.



The baseplate is smooth and has a polished look to it, and it's the reason this heatsink is fairly heavy at 650 grams. Considering the retention mechanism, that weight might be a concern for a few users. That's because this heatsink doesn't use your motherboard for support. Instead, it relies on the socket for support like many other (much lighter) AMD heatsinks. While this simplifies installation, it also means that there's an awful lot of weight pulling on the sides of the socket when your case is vertical. Because of this, you should definitely avoid moving or jarring the case while this heatsink is in place.

With the hurricane force of the Tornado on top, this heatsink performed very well. Motherboard Monitor reported an idle temperature of 40 C and a working temperature of 43 C, while our Digital Doc sensors recorded a rise of one degree when we began benchmarking.

Spire SkiveStream III

We paid: $19
Available at:
www.3dcool.com
www.frozencpu.com

At less than $20, the Spire SkiveStream III was one of the least expensive heatsinks we tested, so you might be surprised to hear that this product does include copper. It also has a nickel coating that adds a chrome-like shine and also comes with a preapplied layer of thermal grease for those of you tired of playing with the messy stuff, and although this layer was too wide for the top of our CPU's die, it's easy enough to wipe the excess off of the shiny finish.

Compared to the 600-gram monsters that we tested elsewhere in this story, the SkiveStream III is quite small, so at only 65mm tall (with a fan), you will have plenty

of room for your other components and cables. It comes with a translucent blue fan that spins at 3,600rpms and moves air at 32.25CFM.

In a nice touch, Spire added a fancy chrome-like fan grill that spices up the product's look and prevents wiring and finger damage. If you like classy-looking components without overblown glowing and blinking effects, this is a good option, and the fan wiring has a whitish shielding that will match up with most color schemes.

The Spire's performance was very good, especially when you consider how much we spent on it. Our CPU did get as warm as 47 C, but this is still an excellent budget-priced modding buy.

Vantec AeroFlow VA4-C7040

We paid: $24
Available at:
www.mycableshop.com
www.xoxide.com

You don't necessarily have to spend a lot of money to invest in interesting heating technology. For less than $25, you can nab this Vantec AeroFlow heatsink that has a round, copper CPU core and four-sided aluminum fins that slope from the top and center of the heatsink toward the bottom edges. This design supposedly results in smoother and more consistent heat dissipation, especially at the heatsink's corners, thus, the AeroFlow moniker.

VANTEC
AeroFlow
Features
AeroFlow Heat Sink Design
TMD (Tip-Magnetic Driving) Fan
Copper Core for superior heat dissipation
PREMIUM
CPU cooling fan
TMD Fan
Designed For Socket A/370/7
& Socket 478
KEEP it COOL.....
AeroFlow

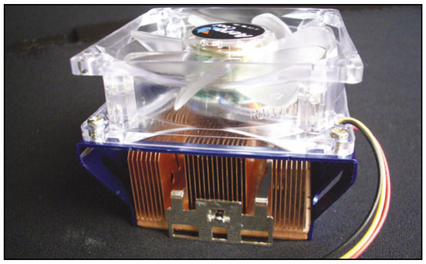
Vantec didn't forget about the fan during the research and development process. This unit includes a TMD (Tip-Magnetic Driving) fan, which, unlike most fans, doesn't have a center-mounted motor. Instead, the motor is displaced to the fan's four corners, which reduces the fan's hub size and, as a result, shrinks the dead spot that's associated with regular fans.

Installing the heatsink is easy, as you just clip it onto the CPU socket and connect the fan. Its diminutive size and plain-Jane metal top, along with the black fan blades, look a little drab at first, but turn on this Vantec, and its artistry comes to life. From a vantage point above the spinning fan, you can see the copper core and unique fin arrangement, an x-ray type view that blows away cheap-looking LED effects.

At about 65mm tall, this heatsink will fit in most cases with no problems whatsoever. It will also cool your AMD chips without difficulty. Even with a heavy workload, our CPU maxed out at 42 C, making the heatsink cool enough and cool-looking enough for the most discriminating modders.

Aerocool Phantom

We paid: $30
Available at:
www.tigerdirect.com
www.newegg.com



Aerocool's Phantom is actually designed for XP 2600+ and faster CPUs, but we decided to see how it would work with our slightly slower AMD chip. Aerocool's specs indicate that this product will also help cool Intel Celeron and Duron processors.

The Phantom is immediately notable because it's made from copper and costs less than $30. It weighs a reasonable 300 grams and comes with an 80mm fan that spins at 2,600rpms. It's also topped with a blue metal enclosure that makes for a sharp-looking heatsink, indeed, but you won't get the full eye candy effect until you power on your PC. When you do, you'll see the blue LEDs in the fan come to life. These LEDs help the Phantom offer some of the same attention-getting effects as the Gigabyte cooler.

With our 2500+ CPU, idling temperatures were acceptable and went as high as 42 C. At-work heat levels were higher, at 49 C, but that's still plenty cool for this CPU. Because we tested this heatsink on a CPU just outside its spec range, we won't rush to judgment on performance, but there's little doubt that the Phantom is a good choice for modders who need a smaller heatsink but want a product that will blow bystanders away.

Arctic Cooling Copper Silent 2M

We paid: $22
Available at:
www.frozencpu.com
www.newegg.com

At first, we thought the Arctic Cooling Copper Silent 2M was incorrectly labeled—an annoying whine nearly drowned out our thoughts as we started up this heatsink/fan combo. Then we realized a nearby overclocked machine was the problem. Once we relocated our test machine to a new area, we were surprised by what we didn't hear, a good indication of just how quiet this 80mm really is.

The fan sits atop an aluminum heatsink that contains a 44mm copper plate designed to cover an AMD CPU's high-temperature die. Instead of using a thermal compound between the aluminum and copper elements, the company integrated a very thin layer of tin between these two metals, which supposedly improves heat conductivity by a factor of 25.

We experienced no problems with this heatsink's installation, as it quickly clipped onto the standard AMD socket. In addition to securing the heatsink, we had to install the fan control switch, which is just a basic, black, three-way switch, into an empty expansion card slot.

You won't have to worry about the 2M devouring much case space. It measures less than 80mm high and weighs only about 400 grams, much smaller than the 700-gram heatsinks we tested elsewhere in this story, yet it's still rated to handle up to an Athlon XP 3400+ CPU when you set the fan to its maximum speed of 2,800rpm. Unfortunately, it didn't keep our CPU as cool as we would've liked. Both idle and work temps reached mid to high 40s, which our other test products bettered.

The Cool Down

New heatsinks pop up on retail sites every day, and each new product promises better cooling potential, but almost always at a higher price. As you reread our results, keep in mind that forced-air heatsinks can accomplish only so much, especially during overclocking sessions.

Don't spend $60 on a heatsink until you're sure it can do the job right, keep the product's weight and dimensions in mind, and consider ahead of time whether you want the heatsink to work with both Intel and AMD processors. A little foresight will prevent wasted cash and help your CPU get the cooling effects it needs. CPU

by Nathan Chandler

The Award-Winning MSI K8N Neo Platinum Motherboard is Now Available for Purchase!

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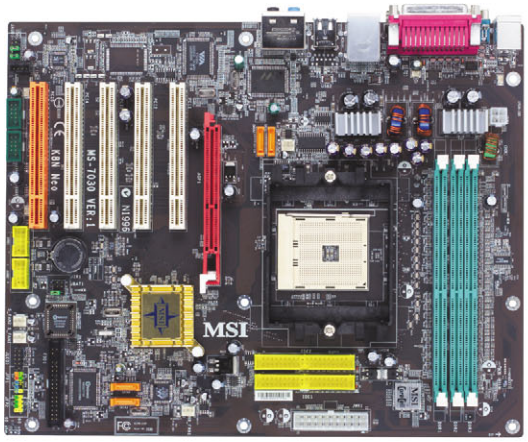

"If you've been holding out for a better Athlon 64 solution, the K8N is definitely the answer you've been waiting for!!!"
- PC Enthusiast Magazine

"The MSI nForce 3 250Gb took every single synthetic and gaming benchmark tested, leaving us with no doubt as to the new performance leader in the Athlon 64 arena ."
- vr-zone.com

"The MSI K8N Neo Platinum is a truly excellent motherboard that competes in every way with the best of the Socket 754 motherboards."
- Anandtech.com

"It's easy to see that the MSI K8N Neo-FIS2R Platinum is a winner . It outperforms the most popular socket-754 boards on the market."
- GamerDepot.com

"The MSI K8N Neo-FIS2R Platinum is an excellent board to work with …… the performance of the MSI K8N Neo-FIS2R Platinum motherboard was excellent. It's easily the fastest Athlon64 board we've tested to date."
- PCStats.com

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A FINE GRIND

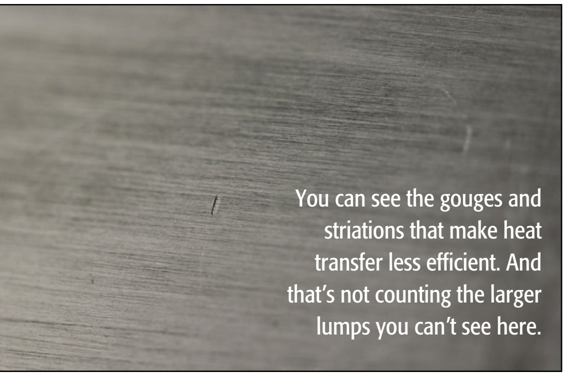
Lap Your Heatsinks To Increase Cooling Efficiency

When high-tech thermal paste, watercooling systems, and jet-powered fans aren't enough, you can always try to make your CPU's heat transfer more efficient by lapping its heatsink. Put your tongue away—that's not what we meant. Lapping is a basic procedure that requires just few tools and a little arm strength. Tongue-to-metal contact is completely optional.

Lapping Is Happening

Lapping means to smooth out a surface so that it's perfectly flat, and it's used in many industrial processes. Many users lap their heatsinks to make them flatter and produce more even contact with the top of the CPU. This helps the heatsink absorb heat more quickly, and as a result, assists in keeping the CPU cooler. Random reports on the Web claim that lapping can drop CPU temps by as much as 5 degrees Celsius.

But isn't the bottom of your heatsink already flat? High-end copper heatsinks are often prelapped and ready to go, but cheaper stock heatsinks rarely make perfect contact with the CPU, which is one reason you use thermal grease. This slimy, messy substance fills in all the tiny spaces that inhibit the movement of heat from the CPU and heatsink. Grease works best for minute gaps, though, not the kind of wholesale roughness that we'll eliminate through lapping.



You can see the gouges and striations that make heat transfer less efficient. And that's not counting the larger lumps you can't see here.

We'll show you how to lap your own heatsink to increase its effectiveness. In addition to our play-by-play of the lapping process, we will also offer before and after temperature readings to help you decide if lapping is worth the effort.

Lap It, Lap It Good

Lapping requires very little in the way of tools. We gathered up a piece of thick glass, several pieces of sandpaper of various grit (or coarseness), a cheap white surgical mask like you've seen a hundred times on "ER," paper towels, and water. Lazy types like us actually order lapping kits that have everything you need for a lapping session, and such kits are handy because they include several types of sandpaper, a fact that prevents you from having to buy several expensive multisheet paper packets.

And you *will* need sandpaper with different grit. As you shop, you'll see that manufacturers denote coarseness with a number system, and the lower the number, the coarser the grit. For CPU heatsinks we recommend starting with 400 or 600 grit sandpaper. Wet/dry sandpaper designed for automotive work is fine, and you can pick up 600, 800, 1500, and even finer-grit sandpaper at auto parts stores, but it's not necessary to buy anything higher than 2000 grit.

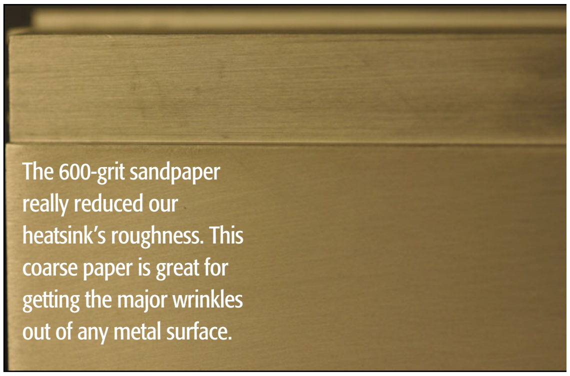
You might ponder the idea of using power tools as a substitute for sandpaper, but we don't suggest going that route. The purpose of lapping is to smooth over bumps and pits on your heatsink; it's not necessary to remove massive layers of metal. Doing so will only reduce your heatsink's mass, and thus, its ability to reduce your CPU's operating temperature.

You should prepare a perfectly flat surface for your sanding operation. Don't use a bumpy tabletop or workbench because those bulges defeat the purpose of this project, and make sure your surface is low enough to let you apply downward force with ease. Many people use a sheet of a glass as their sanding surface, and our kit actually included a 6- x 6-inch glass square for our convenience.

Before starting, it's best to determine exactly how much lapping is necessary for your particular heatsink. You can do this by pressing the flat blade of a butter knife against the heatsink surface. This helps reveal any massive irregularities that you can attack with your sandpaper and gives you an idea of just how much work you have ahead of you. No matter how flat or rough your heatsink is, be sure to set aside enough time to do a good job. We spent about an hour and a half grinding down the surface of our heatsinks.

Lap Away

If you don't have a garage or a workspace where you can get as messy as you want, old newspaper is your new best friend. Spread multiple sheets on and around your work area to collect aluminum dust particles and prevent splatters. Be sure to wear your dust mask to reduce the amount of metal dust you inhale—once you begin grinding your heatsink, much of this dust will go airborne, and believe us, you don't want this gritty stuff in your lungs. Wear old clothes for this procedure. Lapping will spray droplets of water throughout your work area, and it's not easy to remove ground metal from that new Leftover



The 600-grit sandpaper really reduced our heatsink's roughness. This coarse paper is great for getting the major wrinkles out of any metal surface.

Salmon T-shirt. Also consider wearing a pair of work gloves and have a few rags or a roll of paper towels handy.

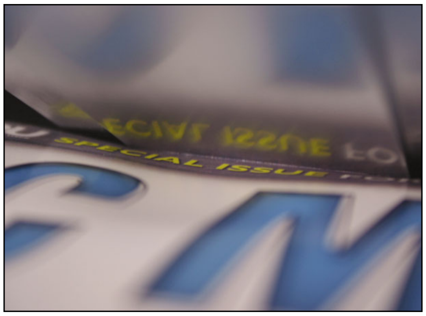
1 Remove the fan assembly from your heatsink. Most fans use a simple clip system that you can remove in just a few seconds. If you can't remove the fan without damaging it, you can lap the heatsink with the fan in place, but this makes it more difficult to apply consistent pressure.

2 Put a few drops of water on the glass plate and wrap the sandpaper over the plate's edges to keep the paper from sliding around too much. Now pour a bit of water on the paper's surface. Begin lapping with the coarsest paper at your disposal and work your way to the finer grits. How exactly should you grind the heatsink? Some people claim that a circular or figure-eight motion is best for creating the flattest surface, and others insist that a straight back-and-forth technique yields optimal results. The reality is that both actions—when paired with even pressure and a smooth stroke—will create a surface far superior to the manufacturer's machining process. But if you long for a mirror-like finish on your heatsink, a back-and-forth motion creates the slickest shine.

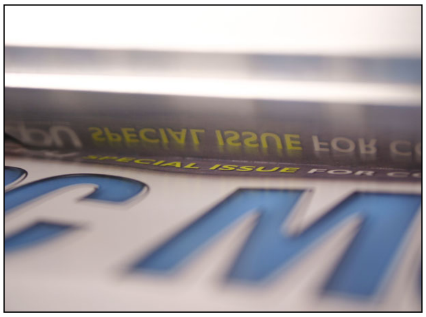
3 Many heatsinks have sharp edges and corners that snag and tear sandpaper. If you have this problem, you can tilt the heatsink and use the paper to rub those edges into complacency.

4 Don't use arm-quivering force to lap; instead, apply easy, steady pressure and let the sandpaper do its job. You'll encounter more resistance if you use a circular motion, another reason we recommend the simpler back-and-forth technique. If you lap in circles, rotate the heatsink after every few dozen strokes; rotate the heatsink 180 degrees if you're grinding back and forth. Rinse the paper and heatsink often to eliminate accumulated dust.

5 Switch grits after you can see a significant improvement in the heatsink's surface. You may have to use more than one sheet of a specific grit, especially if you're encountering snagging problems or if you just want to be absolutely sure you are getting the smoothest surface from each grit. Before you change papers, rinse the heatsink and glass thoroughly; otherwise, you risk introducing leftover particles of coarser paper into the work area. Such particles will reduce the polishing benefits of finer-grit papers.



The 1000-grit sandpaper smoothed things out, but the metal doesn't yet have the shine we're looking for.



Our final product has a nearly mirror-like finish that makes better contact with the top of the CPU.

6 After you achieve the desired level of smoothness, it's time to clean your heatsink. Rinse it thoroughly with water and scrub it with a stiff brush to remove trapped metal grains. You can use denatured alcohol to exorcise minute particles that your other cleaning efforts miss, but this chemical treatment isn't necessary.

7 Once the heatsink is dry, apply a thermal compound to the top of your CPU and reinstall the heatsink/fan.

8 If you didn't wear gloves, wash your hands thoroughly to remove all visible traces of metal dust.

Friction Blisters Rock!

Our tests demonstrated that lapping does seem to lower CPU temperatures. Nailing down exact CPU temperatures is often an inexact science, but sensors from our MacPower Digital Doc showed that prior to lapping, the sides of our heatsink rang in at 28 C while the CPU was idling, and 34 C when we put it to work. We also took readings from the CPU itself using Motherboard Monitor (www.mbm.livewiredev.com), a program that monitors motherboard temperatures and displays them on the Windows taskbar. The program indicated that our CPU was 28 C at rest and 38 C during a benchmarking routine.

After we lapped our heatsink, the Digital Doc recorded the same temperatures as before. That would seem to be at odds with lapping logic, which says that the heatsink's temperature should rise as heat is transferred more quickly from the CPU to the heatsink. However, our efforts weren't in vain.

More telling temperature readings came from the CPU itself. Motherboard Monitor registered an idle temperature of 28 C and a working temperature of 36 C, a two-degree drop. Keep in mind that we took these readings from a heatsink we'd lapped using a circular motion. We repeated our tests using an identical heatsink lapped in a back-and-forth fashion that produced a glossy finish. Resulting temperatures were identical to those we saw from the first heatsink.

Lap Like Mad

Our results were in line with what many other users experience—most lapping results floating in Internet chat rooms and forums indicate that it's a significant feat to drop your CPU's temperature by three degrees. You might think three degrees isn't worth a few bucks and a couple of hours of your time, but that decrease in excess heat may very well help you achieve better overclocks, and the extra cooling efficiency may add time to your CPU's lifespan. CPU

by Nathan Chandler

WORKING WITH GREASE

Get Lower Temps & A More Overclockable Chip

You already know that your CPU runs too hot for its own good. It needs a heatsink or cooling block attached to it so that it can dissipate heat. In a perfect world, the perfectly smooth sink would sit perfectly flat against the perfectly smooth processor die.

In the real world of mix-and-match commodity parts, tiny imperfections in the heatsink and die cause air gaps between them. Air is an insulator, so heat has a hard time emigrating from the CPU to the heatsink.

Enter TIM. A thermal interface material, often called a thermal compound, grease, or paste, fills the gaps between a heatsink and a processor. A good TIM is so much better than air that you shouldn't run most CPUs without one.

What To Buy

Thermal greases available today are generally oils suspending metal and/or ceramic particles of silver, boron nitride, and other materials. Manufacturers try to offer good heat conductance, low electrical conductivity, and stability so the compounds don't leave the die or break down.

Your options include Arctic Silver 5 ($7) and Ceramique ($4; www.arcticsilver.com); Nanotherm PCM+ ($9; www.nanotherm.com); and GEIL's Copper Thermal Compound ($8; www.geilusa.com). Avoid using a thermal *adhesive* for a CPU heatsink, however. One of these acts like a TIM, but also like a glue. See the "Removing 'Glued' Heatsinks" sidebar for more info.

It's inordinately tough to properly compare thermal compounds to find the best one. (A supply snafu thwarted our efforts to do so by deadline.) Arctic Silver's Colin Thompson says that there's no practical way to completely remove thermal grease from a heatsink or CPU before applying another one. This means that you really need an uncontaminated, virgin heatsink and processor for every compound you test. And because those sinks and chips won't be identical, your test will still have some variation. In case you do your own testing, Thompson advised using Pentium IIIs. PIIIs have internal thermal diodes in the hottest parts of the chips, he says, unlike P4s or Athlons. P4s also throttle their clocks when they get too hot.

Meanwhile, Intel is researching a new TIM using carbon nanotubes, which conduct heat well and are minute enough to fill extremely small voids. "If it pans out, (the new compound) could be used in a few years, but it is really too early to tell," says Intel spokesman Manny Vara.

Thompson says that carbon nanotubes are "not on the menu at this time for our current products." He says that nanotubes' tendency to conduct heat in only one direction makes them better suited to thermal pads than greases. Despite the "nano" in its company name, rival TIM maker Nanotherm declined invitations to discuss its ingredients.

How To Apply

Like any component in your computer, there's a right way and a wrong way to install a thermal compound. If you just squeeze a dollop of thermal grease onto your CPU and snap the heatsink in place,

Hi, No Silver!

In January, Silversinksam, a reviewer at Overclockers.com, found that neither OCZ Ultra II Premium Silver Compound nor CompUSA Silver Thermal Grease contained any silver, as claimed. Independent testing backed up his findings. The aluminum- and silicon-based TIM, reportedly from the same supplier, couldn't transfer heat as well as it would have with real silver in it.

OCZ immediately verified the problem, and initiated a very generous recall program for the inferior compound (http://www.ocztechnology.com/aboutocz/news/3). CompUSA also pulled its product. However, as of this writing three months later, CompUSA makes no mention on its site of the problem, nor of any recall. ▲

Removing "Glued" Heatsinks

Some heatsinks, like Joan Rivers, seem to have no visible means of support. They're not screwed down nor held by clips, yet they cling tenaciously to the silicon chips they cool.

Some manufacturers attach heatsinks to motherboard northbridges, MOSFETs (metal-oxide semiconductor field-effect transistor), or RAM modules on video cards with thermally conductive adhesives or double-sided tape. CPU heatsinks have grown too big and heavy for most thermal adhesives. In very rare cases, though, you may find a smaller sink stuck to a chip you want to uncover.

A heatsink affixed with thermal tape is no problem to remove when it's hot. Gently twist it one way, then the other, until the tape lets go. Don't pull or pry upward on the sink.

If you encounter a sink that won't budge at all, it's probably stuck on with a permanent adhesive, such as Arctic Silver, Alumina Adhesive, or Nanotherm Epoxy. Ask yourself if removing that heatsink is worth the risk of breaking the socket, the motherboard, or the processor.

If so, try OverclockerCafe.com's method: Heat the chip with a hairdryer. Protect the circuit board with a credit card and then twist the blade of a flat screwdriver between the card and the heatsink. ▲

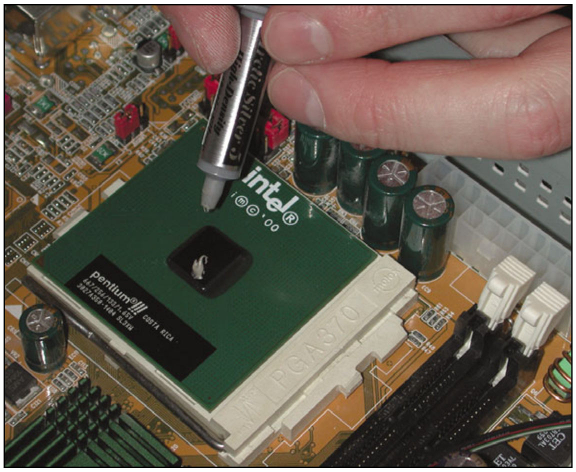
your chip will probably run hotter than if you had cleaned it beforehand and applied the TIM properly. Even worse, stray globs of conductive thermal compound, such as most silver-based ones, can short out exposed transistors and contacts surrounding the die. These can kill your chip.

If your TIM didn't come with detailed instructions, follow these steps. With the computer unplugged, remove the CPU's heatsink and fan together. This usually involves carefully pressing downward and outward on the heatsink's retaining clip with a flat-bladed screwdriver. Don't slip, or you might gouge the motherboard. When the clip comes free, unhook its opposite end from the socket. Set the heatsink aside. If the heatsink doesn't come off easily, refer to the "Removing 'Glued' Heatsinks" sidebar in this article.

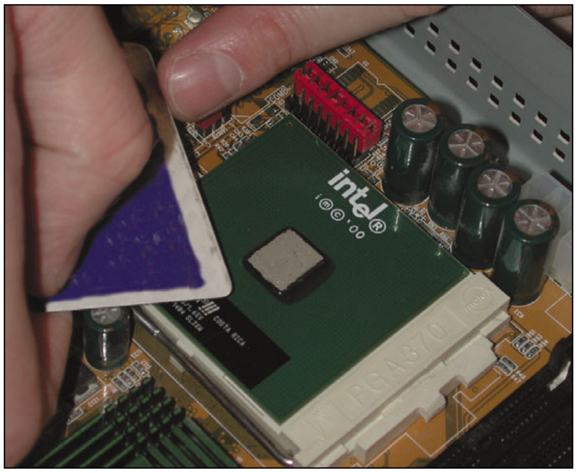
Next, gingerly clean the processor's die, which is the core chip in the center of the CPU package (see our photos). Use a soft cloth dampened with a cleaner that won't leave any residue, such as pure isopropyl alcohol or Akasa TIM-Clean ($10; www.akasa.com.tw). Be careful not to smear the old thermal grease onto other parts of the CPU's package as you clean it off. Wipe the old TIM from the heatsink, as well.

When you're ready to reassemble things, squeeze out an amount of thermal compound about the size of a capital letter "O" onto the center of the heatsink's underside, where it will contact the CPU die. Use a clean cloth to rub the grease into the heatsink until it's all but dry. This prepares the sink for better heat transfer by filling in any microscopic pores and machining marks.

Next, apply your TIM to the processor die as shown in the photo. In one corner of the top of the die, deposit a drop of thermal grease about the size of a lowercase "o." If you find that you need more later as you spread the compound, you can add a tiny bit more then. When you're working with thermal grease, remember that too much is just that: too much. Excess compound will simply squeeze out when you clamp down the heatsink.



Apply only a little bit of thermal compound at first. You can always add more later.



Use a credit card with a burr-free edge to spread the grease over the die. Avoid bubbles or bare spots, and be very careful to keep the stuff off the rest of the processor package.

Rub thermal compound into the heatsink to fill the pores of the metal. This step could shave a few degrees off your temps.

Now spread the grease evenly and thinly over the *top* of the die, using a clean-edged credit card, laminated driver's license, or what have you. You want a smooth film of thermal material on the die's surface, without any grooves, bubbles, or bare spots. Applying the wet layer of TIM to the processor die instead of the heatsink minimizes the risk of getting compound on other parts of the chip package.

Finally, hook the nonadjustable end of your heatsink's retaining clip over the tab(s) on the CPU socket. Try to set the heatsink down onto the processor while keeping it as level as possible. Carefully use your flat screwdriver to reattach the other end of the clip to the socket. Heatsinks for newer chips, such as the Athlon 64, may attach via levers to a plastic bracket instead of the socket.

Plug in the heatsink fan before you start the PC, and be ready to turn the computer off quickly if the BIOS or monitoring utility shows that the CPU is getting too hot (70 degrees Celsius for an Athlon 64, for example). Many recent motherboards will automatically shut the system down if the CPU temperature spikes, but others won't.

Note that most TIMs will improve CPU temperatures a few degrees Celsius over a few days' break-in time. Properly applied, the right thermal grease should help your chip last longer and overclock higher. CPU

by Marty Sems

Dry Ice Destruction

Supercool Your CPU On The Cheap, Mad-Modder Style

Sometimes we are inspired to perform certain feats because a bold mentor showed us a way to reach for the stars. Mad Modder won't offer up such clichés when explaining why you should cool your CPU with dry ice. Because you already know why you should take your chip into the dry-ice deep freeze—Michael Myers told you to.

I was watching "Halloween" and wondering exactly how I could vent some antisocial angst on my computer components. And as I watched Mr. Myers chopping and slashing, I realized I could do the same, only with dry ice, which in bits in pieces I could use to take my CPU temperatures to torturous lows. After properly fortifying myself, I gathered my strength and prepared for the coolest middle-of-the-night project ever.

Cooling with dry ice means a number of things. One, because dry ice is so cold, you can achieve incredible overclocks. Two, dry ice means that you'll have to take a few precautions to protect your expensive equipment, lest it wind up as a useless testament to your slapdash safety skills. And three, you have to figure out a way to get all that beautiful dry ice coldness onto the top of your CPU without spending a ton of money. Read on, and I'll teach you how to protect your motherboard and CPU and show you just how far I pushed my test processors. Michael Myers, eat your heart out.

Setup details

Start this project by assembling a list of required hardware. I began with the electronics, including an average Intel Pentium 4 and two AMD Athlon 64s; all the better to get a good idea of the effects dry ice would have on a midpriced CPU, as well as a pair of blazing 64-bit superstars.

From there, putting things together requires a little more thought. You need a way to seal the CPU socket to prevent condensation. For this task you need dielectric grease, a waterproof sealant (I recommend RTV sealants popular with modders), and neoprene or closed-cell foam. I'll provide a general overview of how to seal your CPU socket here, but you can find detailed instructions on page 148.

You will also have to consider how to apply the dry ice to the top of your CPU without deep frying its transistors or getting crazily cold chemicals all over your motherboard. Because complex plans always seem to fail miserably, I decided to keep this part of the project simple: I used a Mountain Dew can. That's right, Junior, I spent 50 cents on a soda for this project, and it wasn't so that I could mix the sugary stuff with Cuervo for a drink as I worked. I'm sure you're wondering, why, Moddy, why?

I used a pop can primarily for simplicity's sake. As you cruise the Web, browsing other users' dry ice projects, you will inevitably run across those who integrated custom-made copper or aluminum heatsinks to the top of their CPUs. So unless you happen to own a machine shop, you won't have the ability to perform this project at 3 in the morning on a Saturday. You could hire someone to make a dry ice receptacle for you, but A) you'd have to wait for the item to be constructed, and B) this would cost you a nice lump of cash you could spend on other fun stuff, for example, beer.

The Can Plan

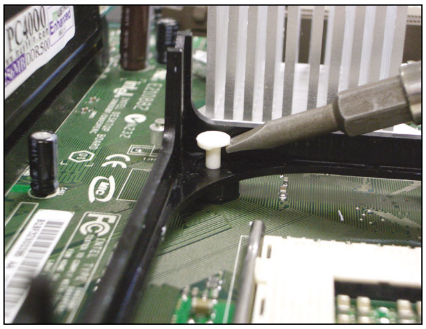
Most CPU heatsinks are made from aluminum or copper because these metals have superior heat transference characteristics. But when you know you're going to be working with something as cold as dry ice, that thin layer of metals separating the ice from the CPU doesn't seem quite as important. Plus, the recycling truck doesn't make any pick-ups outside this godforsaken hovel in which I hide, so my stockpile of extra cans is hitting an all-time high.

As you know, the bottom of a Dew can isn't flat; instead, it has multiple ridges that would prevent it from making good contact with the CPU. Fixing this was easy. I upended the can onto top of a flat pole and beat away on the bottom of the can with a hammer, thinking all the while about my former boss. Doing this flattened out most of the biggest imperfections, and a quick lapping job smoothed out the can even more.

I put a little extra work into my can alterations because of the thin aluminum's flexibility. I knew that if I simply made the bottom as flat as possible, it would pop up a little when I tightened it to the top of the CPU, causing a concavity and ruining the can's heat-conductive properties. To avoid this problem, I left the can smooth but convex at just the right angle—when I pushed it down on a tabletop, it looked perfect, with the bottom flattening out to make consistent table contact.

The next big step was figuring out how to make the can sit on top of the CPU without tipping over, but securing the can to the CPU turned out to be one of the easier tasks in this project. I unscrewed the plastic heatsink mounting bracket and removed it from the motherboard, set the can on the CPU, placed the mounting bracket on top of the can, and inserted two 8-inch long screws through the bracket and into the motherboard's predrilled mounting holes. A couple of nuts made sure the assembly stayed in place with no wiggle whatsoever.

Affixing a bizarre contraption like this to your CPU, means, of course, that you



This Socket 478 bracket comes off and will actually secure my pop can to the top of my CPU.

won't be putting the motherboard back in your PC's case. It's fine to leave your motherboard on your tabletop for the short time it takes to perform this experiment; just be sure to take the proper procedures to reduce the chances of an electrical static discharge. You can rest the mobo on a soft foam pad overlaid with the motherboard's antistatic bag, if you like. I actually removed a side from an old ATX PC case, laid it flat on a counter, and secured the mobo to the standoffs, making the board level and stable for my experiments.

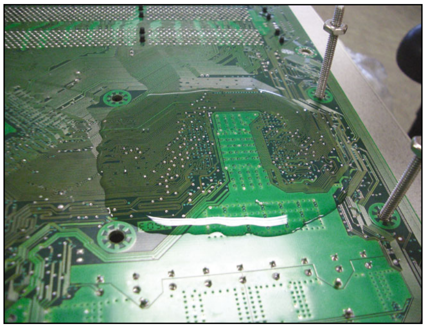
Condensation considerations. You can't use dry ice for cooling unless you take proper precautions to minimize condensation problems. You *will* encounter condensation during this experiment because condensation almost always forms when you keep an object colder than the surrounding air, and I'm sure I needn't remind you that dry ice is about -80 degrees Fahrenheit.

So be sure to use the steps for insulating your socket on page (REFER), but with a few minor alterations. With dry ice, the insulating pad on the backside of the motherboard isn't an option; it's a necessity. After you've applied and let dry your silicone sealant, cut a foam rectangle that extends at least a couple of inches to either side of the CPU socket. Cut small holes in the foam to accommodate any nuts used to secure the dry ice bracket and then use a silicone sealant to make the pad stick to the motherboard.

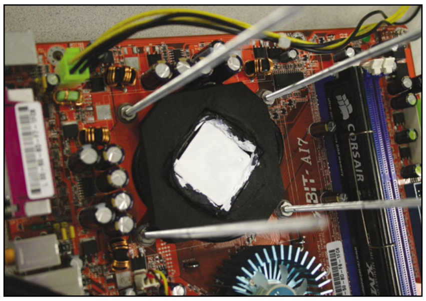
It's important to insulate the can, as well, to keep watery messes to a minimum. I wrapped my can in a half-inch of closed-cell foam and then sealed the whole thing up with waterproof tape. When I was done with my can, only the flattened bottom and the top hole for receiving the dry ice were visible.

After I secured the can to my CPU, I also dug out a couple of old plastic bags and draped them over my motherboard. If you're not particularly well coordinated, consider this a necessity because bumping your can during this experiment can unleash a flood of supercooled liquid over your motherboard, and that's the end of the fun.

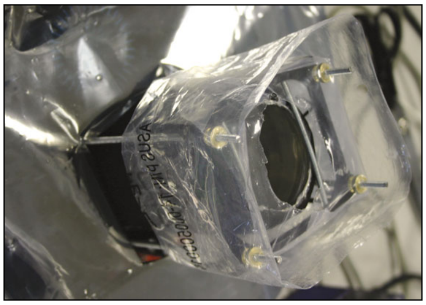
When your CPU socket is protected, it's time to play. Just keep in mind that these precautions will protect your motherboard only for short overclocking sessions and that using dry ice on a regular basis can be dangerous for your sensitive equipment.



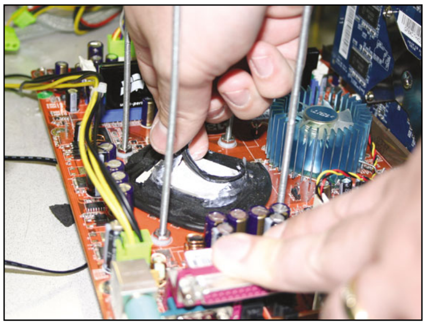
This is dried conformal coating on the back of the Intel mobo. A piece of neoprene or foam makes the area resistant to condensation.



The well-insulated socket is ready for a tall sip of dry ice, via a Mountain Dew can.



Klutzes, take heed, this how is you should protect your mobo from splashes during the experiment.



Turns out there was too much insulation on the mobo, so I took it off. It's worth noting that this is the last time my P4 was seen alive.

Don't Die, Please

Dry ice isn't a harmless plaything. Those drunken chimpanzees outside our base in [CENSORED] know this, and judging by their poor, frostbitten parts, you don't want to repeat their mistakes. So treat dry ice with respect. I'm sure you're thinking, "The stuff is minus 80 degrees Fahrenheit, it's not like I'm going to make dog food slushies and feed them to angry, duct-taped terrorists." Because that would be wrong. In most cases.

But I digress. Realize that dry ice can hurt you, mostly by freeze-burning your skin and making it look like you barely survived a five-alarm fire, so don't let this stuff come in contact with your bare flesh. Wear gloves or oven mitts when you're handling the chunks.

If you don't have anything more appropriate, buy a cheap Styrofoam cooler for your trip back from the ice store. This cooler will slow dry ice's tendency to sublimate into the air as carbon dioxide. If you use some other type of container, just make sure it's not completely airtight, as the sublimating dry ice will expand and could cause an explosion. Don't, *ahem*, get any bright ideas.

Use dry ice only in a well-ventilated area. Because dry ice disappears so quickly, you need at least five pounds of it, even for small projects, and its sublimation increases the ratio of carbon dioxide around your cooler. I doubt many of you will be putting this project together in a glorified closet, like me, but you do have to transport the ice home in your vehicle. Crack a window or make sure the ventilation system is blowing fresh air into the car to avoid any oxygen deprivation issues.

Dew Dee Dew

I decided to begin my experiment with the Pentium 4, all the better to whet my excitement for the Athlon 64s. This was a P4 2.4GHz CPU that I installed on an ABIT AI7 motherboard. In part I started with a P4 to see just how long I could use dry ice with the P4 before condensation- or temperature-related problems caused a disaster, all the better to help avoid catastrophe with my more expensive components.

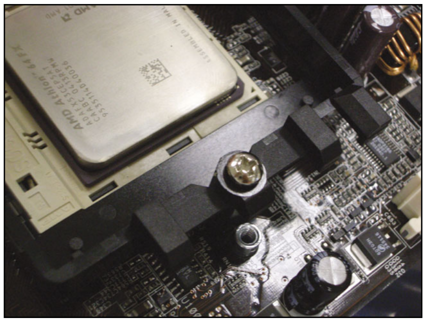
One concern was that the thin walls of the Dew can wouldn't withstand the extreme temperatures of the CPU and the dry ice. After a few more High Lifes, I wasn't concerned anymore. There was only one way to find out if I'd suffer a horrendous, frosty accident or emerge with an intact mobo and CPU in triumph, and that was to give it a go.

The can, revisited. Before jumping into the dry ice procedure, I'll tell you about the re-engineered can. After overclocking for two straight hours, extreme temperatures began taking their toll. Condensation wasn't a problem. My well-insulated motherboard didn't suffer any water-related damage even though the entire dry ice can frosted over completely. But the can itself showed the effects of too much cold and too much heat, and the sides began to bulge a little, much as a full can of soda will do after it's been left in a freezer for a few hours.

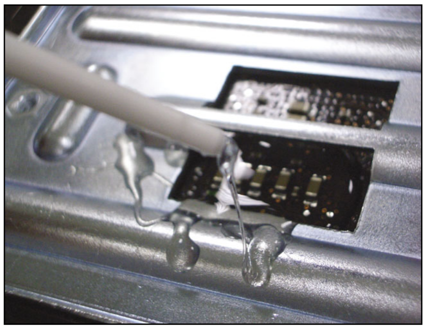
I'll mention here that this bulging monstrosity wasn't the same can as the one I instructed you to make earlier in this story—my initial can had less insulation and no tape to help it hold its shape. I pitched the first can and used the better-insulated one to make sure the bulges of the doomed can wouldn't cause problems with the CPU-to-can contact, and my results were much better. The point, of course, is that your can can't really be over-insulated on its sides, and the more effort you use to prepare your can at the beginning, the less you'll have to worry about later on.

Nice ice, baby. I dropped in a few chunks of dry ice and inserted my homemade funnel so that I could top off the ice with a 1/3 of a can of acetone. The mixture spit a little, but not enough to cause any concern. This particular aspect of testing should be performed with care. Reversing this step by pouring acetone onto the dry ice is a mistake, as this will cause the concoction to explode like a witch's brew gone bad, and when I did it (after one, er, three too many High Lifes) I was very, very glad I'd worn thick gloves, a long-sleeved shirt, and protected my motherboard protected with a plastic sheet.

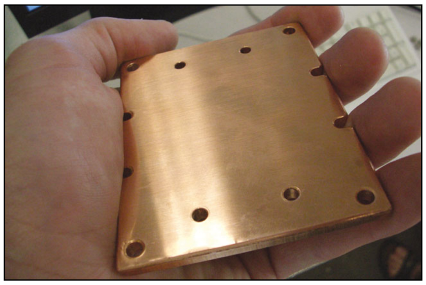
Then it was time for the moment of truth. I hit the power switch, and the P4 computer booted properly but then shut down twice in a row. I carefully released the can's bracket to make sure the can was making sufficient contact with the CPU, and it turned out that I probably overdid the socket insulation, causing the can to lift up just a little too much to touch the CPU. I removed part of the insulation (but made sure the socket was still sealed) and again secured the can. The PC booted up, but only after I hit F2 to bypass my motherboard's CPU fan error, something you'll likely have to do with your system, as well.



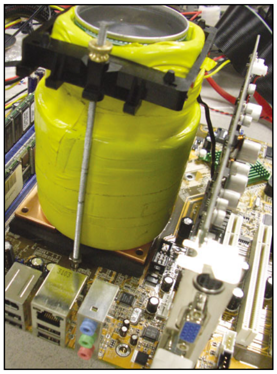
As with the Intel bracket, I removed this AMD bracket and used it to make sure the can stayed put on the Zen plate.



Insulating an Athlon 64 mobo is a messy job. Just be sure you don't get any goop in your socket pinholes, or your board is toast.



This plate, from the bottom of a Scythe Zen heatsink, was a critical reason the Athlon 64 temperatures dropped to -30 degrees Celsius.



Keep it simple, stupid. About all I needed to supercool my CPU was a socket bracket and pop can.

My system started normally, and Motherboard Monitor indicated a CPU temperature of -1 C. I let the system sit to see just how far temperatures would plummet, and after about 10 minutes, it bottomed out at -14 C. I started the PCMark utility and watched that temperature rise. And rise. And eventually skyrocket to 60 C in a matter of minutes, not long enough for the benchmarking scheme to run its course.

I hypothesized that my thin can, though very cold, might not have the heft necessary to pull heat quickly from the CPU. To combat this I decided to give the dry ice a head start. I let my CPU sit without power for two minutes, chilling it to the tips of its tiny transistor bones (more specifically, -18 C), and then I started PCMark again. This time PCMark completed, but very slowly, and to the tune of only 1638 measly PCMarks.

Yin for my yang. The problem was clear—my pop can experiment would fail unless I could find a way to more evenly distribute heat coming off of the CPU. But where in the heck do I find an inexpensive, flat metal plate at 2 in the morning? That was when I spied a Scythe Zen heatsink slumped over like a forgotten Raggedy Andy in my discarded-tech pile.

This particular heatsink has a unique design in that it requires no fan, no water, and no dry ice, but rather, many metal fins that push heat into the surrounding air. It also happens to come with a removable copper plate. I stripped this plate from the Zen, and because it's Socket-478 compatible, the plate slipped over the screws of my bracket and neatly into place.

I secured my can to the top of this plate and restarted the experiment. Praise be to Cuervo—it seemed to be working very well. After computer completed its start-up tasks the CPU temperature was -9 C, nearly 30 degrees lower than when I started up without the copper plate. I let the CPU idle for 10 minutes and the readings went much lower this time, all the way to -32 C. I started PCMark and the temperature began a slow upward climb. By the end of the test, my overclocked CPU's temperature topped out at a mild 43 C and a PCMark score that zipped past 4200.

Although the chip's PCMark scores improved with the dry ice setup, my overclocking sessions didn't accomplish as much as I'd hoped. My can's liquid temperature stayed at a brisk –80 F for almost the entire experiment, and I did push the CPU into 3GHz territory, but in the end, condensation went on the offensive, taking advantage of my tactical error of removing extra socket insulation. My chip flew fast and high, but to a soaking silicon socket in the sky. It was a sad death for this CPU, but its sacrifice paved the way to the next segment of my project.

Ice Cold Ice Cold Ice

Dry ice is one of the cheapest, fastest, and most effective ways to supercool your CPU. It's perfect for a Saturday overclocking session when you want to push your CPU's benchmarks as high as they can go. (Temps in degrees Celcius.) ▲

Pentium 4 2.4GHz		
	Stock Setup	
	PCMark04 Score	
Base chip speed	3591	
Overclocked	3762	
	Operating temperatures with stock heatsink	
	Digital Doc	**Motherboard Monitor**
Idling	26	37
During benchmark routine	31	34
	With Dry Ice	
	PCMark04 Score	
Base chip speed	3753	
Overclocked	4211	
	Operating temperatures with dry ice	
	Digital Doc	**Motherboard Monitor**
Idling	N/A	-30
During benchmark routine	N/A	43
AMD Athlon 64 FX-51		
	Stock Setup	
	PCMark04 Score	
Base chip speed	3887	
Overclocked	4145	
	Operating temperatures with stock heatsink	
	Digital Doc	**Motherboard Monitor**
Idling	31	55
During benchmark routine	39	59
	With Dry Ice	
	PCMark04 Score	
Base chip speed	3894	
Overclocked	4385	
	Operating temperatures with dry ice	
	Digital Doc	**Motherboard Monitor**
Idling	N/A	-2
During benchmark routine	N/A	-30
AMD Athlon 64 FX-53		
	Stock Setup	
	PCMark04 Score	
Base chip speed	4729	
Overclocked	4888	
	Operating temperatures with stock heatsink	
	Digital Doc	**Motherboard Monitor**
Idling	32	39
During benchmark routine	38	51
	With Dry Ice	
	PCMark04 Score	
Base chip speed	4432	
Overclocked	5200	
	Operating temperatures with dry ice	
	Digital Doc	**Motherboard Monitor**
Idling	N/A	-32
During benchmark routine	N/A	-17

The 64 Lives!

After burying the Pentium 4 in the backyard, I grabbed a High Life, headed back inside, and prepared my hard drive to work with two more CPUs and motherboards. For starters, I opted for an AMD Athlon 64 FX-51 on an ASUS SK8N motherboard.

I established a few base benchmark numbers and then prepared to perform more dry ice testing. Because the AMD socket is quite different from Intel's Socket 478 configuration, I needed to secure the can and copper plate with a different bracket. This adjustment turned out to be an easy one.

I removed the two screws that the black plastic square around AMD's socket 940, inserted my two long screws until they extended about a half-inch past the rear of the mobo, and secured the screws with washers and nuts. After double-checking my insulation, I flipped the motherboard over, rested the Zen's copper plate and Mountain Dew can on the CPU, and topped off the whole thing with the plastic bracket and two nuts. This setup was perfectly stable.

I immediately noticed a huge difference in temperature levels. I expected the 64 to run hotter than my P4, but the opposite was true. The 64's idling temperature, -30 C, was the same as the P4's, but unlike the P4, my AMD chip stayed very cold during overclocking, and it warmed to only -2 C even at maximum speed. My guess is that the AMD CPU's larger size helped distribute heat more quickly, letting the dry ice perform its job more effectively.

And the test was, effectively, a huge success. Not only did I not kill the chip, but I managed to overclock the FX-51 to 2.52GHz. Next up, I wanted to see if we could overclock an FX-53 higher than the other scores (2.8GHz) in this same issue.

This task, of course, was no problem. I pushed the chip to 2.9GHz and a nice, round score of 5200 in PCMark 2004. Not bad for a midnight excursion into overclocking wonderland.

Conclusion

If my dry ice experiment proved anything (other than the fact I'm becoming a raving lunatic while unemployed), it's that anyone can take their CPU temperatures to frostbite levels without blowing a grand on a phase-change system. Think of dry ice as the great overclocking equalizer—it proves you don't have to be rich to be fast.

And that's a good thing for me because I think the boys at the old office finally found that back door I left in the budget database. Looks like I'll just have to implement another. Mwa-haha-ptth.

by Mad Modder

SEAL YOUR SOCKET

Don't Let Condensation Devastate A Supercooled System

Sometimes when I'm living the High Life, I get crazy ideas, but even at my maddest, I have never really wanted to push a $700 CPU to the limits using only aircooling. It's not budgetary concerns that stop me; it's just that sometimes I think I can hear transistors screaming as they burn into sorrowful oblivion. That kind of thing stays with you. So for overclocking I use supercooling techniques, carefully, to avoid winding up with a water-soaked ASUS, and to protect my precious, shrill transistors.

Why fret about water? Well, supercooling, of course, means using liquid nitrogen, dry ice, both dry and watercooled peltiers, or phase-change systems, and each of these systems comes with one potentially destructive side effect—condensation. Condensation occurs whenever you lower the temperature of an object below surrounding air temperatures, as evidenced by water droplets that accumulate on the cooler object. Cold beer, anyone? When that object is your CPU or motherboard, you can expect catastrophic problems and a serious, imminent dent in your technology-replacement budget.

Preventing condensation at normal room temperatures means sealing the CPU socket to insulate your processor and keep droplets from forming. No, no, Junior, put down that caulk you bought for your mildewed, rust-stained shower. Let Mad Modder show you how to do this the right way.

What You Need

You don't need much in the way of hardware to seal a CPU socket, and the equipment you do need is inexpensive. On the other hand, you may not be able to pick up each of these items at your local superstore, which I might add, is bristling with privacy-shredding security cameras. Shop at a mom-and-pop hardware store instead, or if necessary, order online using your evil stepmother's credit card.

You will need, in no particular order, closed-cell foam or neoprene squares, RTV silicone sealant, or better yet, Dow Corning Conformal Coating. Add to that list dielectric grease, a fifth of Jose Cuervo, and very sharp scissors or a utility knife.

Foam and neoprene. Closed-cell foam or neoprene sheets are the insulating materials that prevent condensation. They moderate the extreme temperature differences between cooling equipment on your CPU and surrounding air.

Closed-cell foam has a number of characteristics that make it appropriate for insulating a CPU socket. It's a polyurethane substance that has many tiny, tightly packed, crush-resistant bubbles, and as such, the foam usually springs back to its original shape even after you subject it to a lot of pressure. The foam resists a lot of abuse, and so long as you don't go after it with sharp objects, it's very resistant to tears. Bubbles inside closed-cell foam offer excellent insulation, and when compressed, those pockets help to create an airtight, waterproof seal that helps stop condensation before it starts.

You can find closed-cell foam on the Web, but it may be faster to pick some up at a craft or hobby store. Whether you know it or not, you've already seen closed-cell foam in your house; it's used for common weather stripping. In a pinch, I suppose you could pick up weather stripping and use it to battle condensation, but you'd have to deal with the messy adhesive on the back.

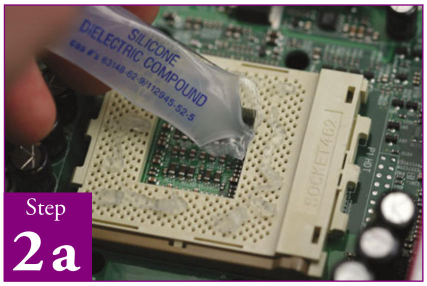
On the flip side, open-cell foam is the kind of stuff you find in Nerf balls. This foam is very soft, crushable, and not water resistant at all. You know what happens when you drop Nerf products into a swimming pool, so don't let something similar happen to your motherboard.

Neoprene. Neoprene is a synthetic rubber. It has a very high resistance to extreme twisting and flexing that damages other materials, and it's waterproof, one reason it is used for everything from wet suits to automotive engine belts. And because neoprene is chemically inert, you can use it in situations where you want to make sure your vital insulation won't melt into a gooey motherboard mess when it comes into contact with a mild solvent or two. Best of all, it's an effective insulator at extreme temperatures.

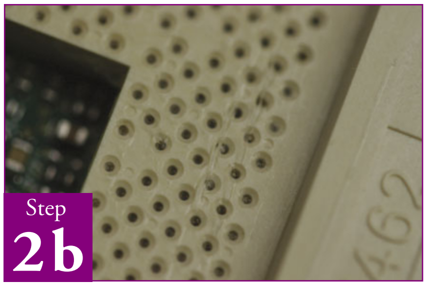
Whether you go with closed-cell foam or neoprene, you need the sheets in a thickness that's appropriate for this project. Keep in mind that 1cm thick sheets are a good starting point, but you can buy both materials in various thicknesses, so to be sure you have exactly what you need. I suggest ordering extras of both thin and thick squares so that you can adjust to any challenges that may arise. These substances are cheap, and you can use leftovers for other projects.

On a final, not-so-unimportant note, it's good to know that you can buy neoprene and closed-cell foam sheets that are precut to fit specific CPU sockets. These precut sheets are a big time-saver, especially for those of you with ham-handed crafts skills. If you want to cut the materials yourself, try the Materialscraps (www.materialscraps.com) Web site for inexpensive foam and neoprene scraps. You can buy enough material here to insulate the entire inside of your PC.

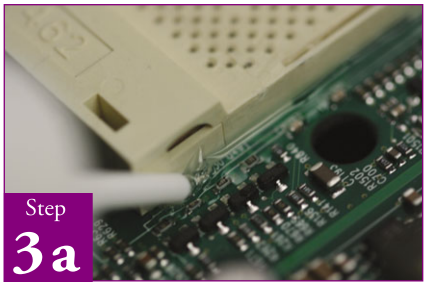
Greases and goo. It's easy to find dielectric grease, otherwise known as spark plug grease. You can pick up a tube of this gunk at any auto parts store for a couple of bucks. This grease's best quality is that it's not conductive at all, so when you smear it all over your CPU socket you won't end up with a flash-fried processor. RTV sealant is a clear silicone sealant that you'll find at a hardware superstore, and it also costs only a few bucks for a tube that will leave you with plenty of leftovers. This particular sealant type works great for our purposes, but it's not pretty, and it's not particularly easy to clean up, either.



Step 2a



Step 2b



Step 3a

Cutting-edge users may very well prefer the Dow Corning Conformal Coating because this substance doesn't leave behind messy looking blobs like RTV sealants can. The only problem is that most conformal coating buyers are businesses that need vats of the stuff. Fortunately, some PC modding sites (such as www.aquastealth.com and www.dangerden.com) now carry the coating for your convenience. I recommend using this product instead of RTV sealant because the conformal coating looks more transparent, and thus, neater, and because you can easily peel it off of your motherboard if you remove your high-tech cooling system.

If you have no desire or time to assemble project components, don't worry. You can access DangerDen's Web site and buy a socket-protection kit that includes everything you need to prevent condensation.

The Act

For the purposes of this article I'll assume you are installing a peltier plate, though in reality you might also be installing a waterblock or even an evaporator head for a phase-change system. Without further delays, let the sealing begin.

1 Uninstall your motherboard and remove the heatsink and fan. Move your motherboard to a well-lighted work area. Remember that you'll have to wait for your silicone to cure, so work someplace where you can leave the motherboard to sit for about 24 hours until you can move to later steps.

2 Squeeze a few big drops of the dielectric grease on the pinholes of your CPU socket. With your finger, smear the grease into the holes. Don't worry about ruining your $200 mobo. The grease is an inert material, and it merely ensures that you've eliminated all air pockets that could play a part in causing condensation. Apply the grease as evenly as you can and make sure it slips into every pinhole.

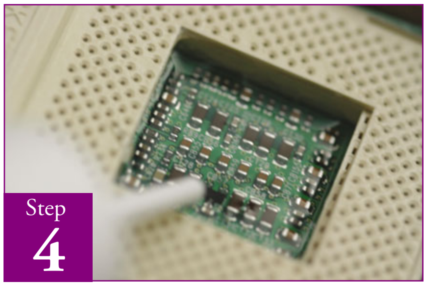
3 Whip out your conformal coating or RTV sealant and apply the gunk all around the base of your CPU socket. This will seal the gap between your CPU socket and the motherboard. You can smear the stuff if you like, but applying an even bead of sealant around the entire base really should do the trick without you needing to make further messes. If you're using conformal coating, take care as you press the syringe plunger. The coating tends to run out of the syringe tip quickly, yet it's still goopy. In other words, it's easy to apply, but things can get out of control in a hurry. Pull back on the plunger to stop the flow immediately, and wipe the tip between pauses. Remember to apply less sealant around the CPU lever to prevent locking problems, and if you use too much, clean up the excess goo now before it starts to dry. A final note on using this splendid, high-tech conformal coating. Initially, it seems difficult to maneuver the coating into tight spots around the socket, but really, it's not. Just squirt a little more coating than you need and then inject more from the other side of the obstacle. Odds are that the two beads will merge together if you tilt the mobo just so.

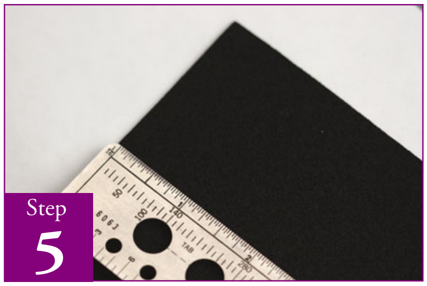
4 Inject the sealant smoothly and evenly into the center of the CPU slug, which is the square in the middle of your CPU socket. Don't completely fill the slug; just verify that you've covered this center square uniformly. You'll need a little space for neoprene or closed-cell foam later in this project.

5 At this point it's best to wait for your silicone to sit for at least a couple of hours, or maybe longer if it's still runny. Then, carefully flip your motherboard and locate the area from which your CPU socket pins originate. On many mobos this area is easy to find because the pins are metallic and create a square shape that's the exact size of your CPU socket. Other mobos cover the bottom of their pins and make the point of origin a little harder to find. If you had a very difficult time finding exactly where the socket boundary is, cover the entire bottom of the mobo with sealant. Heh, heh, I'm just kidding, Junior. Here, drink this. Actually, cover an area slightly larger than the CPU socket with an unbroken layer of sealant on the backside exactly opposite of the socket. Some users claim it's best to affix a neoprene square to the back of the motherboard. If you're paranoid about condensation, feel free to stick your spare neoprene here.

6 Double-check to make sure the sealant you applied is still in the optimal locations. Then let the sealant cure for 24 hours, or however long the manufacturer's instructions indicate. Be advised that conformal coating's slimy stage lasts longer than that of your typical, average silicone sealant. You might want to put a low-speed fan above the coating to speed up the curing process. Later, when you check on the sealant, you might discover that your crazy chemical concoction has partially disappeared. The last time I sealed a mobo, I noticed this phenomenon in my CPU's socket slug, but I took it as a sign that the coating ran under

Step 3b


Step 4


Step 5

the socket and sealed it tight. To be absolutely sure of a perfect seal, I injected more coating and let it sit for another day.

7 Use a ruler to measure the dimensions of your CPU socket. Now use those numbers to cut the neoprene or foam to fit snugly at the base of the CPU socket. These materials stretch easily, so it's OK to cut the holes a tad smaller than the socket.

8 Press the neoprene into place around the socket. The neoprene should be thick enough to bunch up against the edges of the peltier, but remember, you have to leave room to secure the peltier to the socket and motherboard. You may need to cut a slot in the neoprene to make the securing process easier, and if your peltier uses motherboard screws to keep things stationary, you'll have to make the appropriate holes in the neoprene.

9 Cut a neoprene square to fit the CPU socket slug. Tamp the neoprene until it fits neatly into the slug.

10 Reinstall the CPU. Your CPU won't drop into place the way it usually does because of the dielectric grease, and for this reason, you should be extremely careful during this step. Get low and up close to the CPU and make sure the pins are lined up correctly. Press down gently on two adjacent corners of the CPU and slowly work your fingertips across the CPU's surface. This settles the CPU into place and gives the pins some room to displace excess dielectric grease. Gently secure the CPU lock lever. Realize that there will be a little more resistance than usual due to the grease; however, you shouldn't need to use a lot of pressure to complete this step. If it's very difficult to close the ZIFF lever, make sure the slug's neoprene square isn't too thick, and look for other possible obstructions.

11 Your CPU's top surface may have a die, which looks like a small metallic rectangle. If it does, you need to cut a square of very thin neoprene to fit around this die. Most CPUs don't have a die, and if that's the case with your CPU, you can skip this step.

12 Apply thermal grease to your peltier and secure the peltier to the top of the CPU. If you inserted a CPU die shim, make sure this piece of neoprene doesn't bunch up during the installation.

13 Verify that the peltier is sitting evenly on top of the CPU, and make sure the neoprene around the outside of the CPU socket is snug against the peltier, too.

14 Fire up your system and observe the motherboard and peltier very carefully over the next few days. If you see any signs of condensation, you may need to verify that all of your seals are intact and that your neoprene fittings are tight enough.

If you use a watercooled peltier, be sure to watch for condensation on the tubing in your system. Should droplets form, buy pipe insulation and waterproof tape at a hardware store and insulate the problematic hoses. Thus sealed, your condensation worries will be few indeed.

Chill At Will

Understanding the forces that produce condensation, knowing which materials to use for insulation, and sealing your CPU socket will help you put a stop to moisture that can ruin valuable electronics and stop your overclocking cold. There are countless ways to insulate a CPU socket for supercooling, and you now have the basic knowledge to do the job in whatever way you see fit.

Until next time (OK, the next page), drink up, may your modding be mad, and don't forget to make all purchases with cash. You never know who's watching. Mwa-ha-ha (COUGH, COUGH), ha-ha (COUGH) . . . good grief, anyone got a cigarette?

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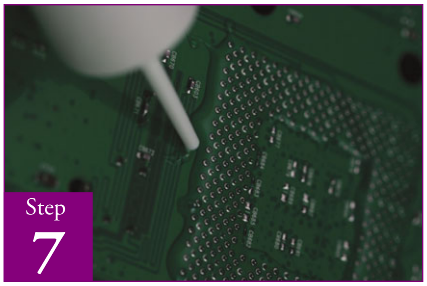
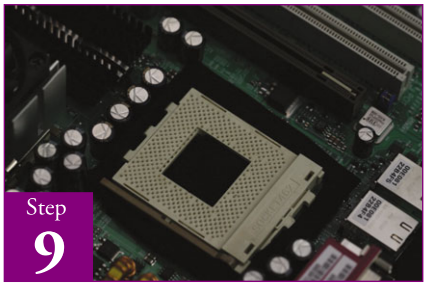
by Mad Modder


Step 7


Step 9

Step 10

HOT FANS, COOL CASE

The Quietest, Most Powerful & Best-Looking Fans

Your computer's cooling system is one of the most vital components to consider when assembling your rig. The mundane case fan is typically the cooling option that receives the least attention when grouped with the more extreme alternatives such as Peltier coolers, massive aftermarket heatsinks, and other supercooling setups (fish tank not included, **see "Light My Fire" on page** XX). The obvious benefit of the case fan is improved airflow, which can carry the heat away from your components by exchanging the hot air in your case with fresh cool air from outside your case. While not capable of cooling below the ambient temperature of your computer's surroundings, case fans can improve heatsink and heat spreader efficiency, and all without *blowing* your budget, or possibly subjecting your components to a watery grave.

A Fan Is A Fan

Decent fans generally cost about $5 and get more expensive with increased power and additional features, such as controllers, LEDs, CCFL (cold-cathode florescent lighting), and temperature sensors. Buying the right fan is about balancing your needs between power and noise output. Then again, killer looks don't hurt either.

Cubic feet per minute. The most important factor to consider when buying a new case fan is the fan's ability to push air. The CFM (cubic feet per minute) rate is the measurement of a fan's ability to move air. With regard to fans, CFM ratings vary widely, from a pointless 8CFM up to a gale-force 120CFM. For standard purposes, a lone 20CFM case fan can move enough air to keep the ambient temperature of a low-end computer in check. On the other hand, overclockers are well aware of the importance of case fans, and frankly in OC'ed systems a single 20CFM exhaust fan isn't capable of moving the heat quickly enough.

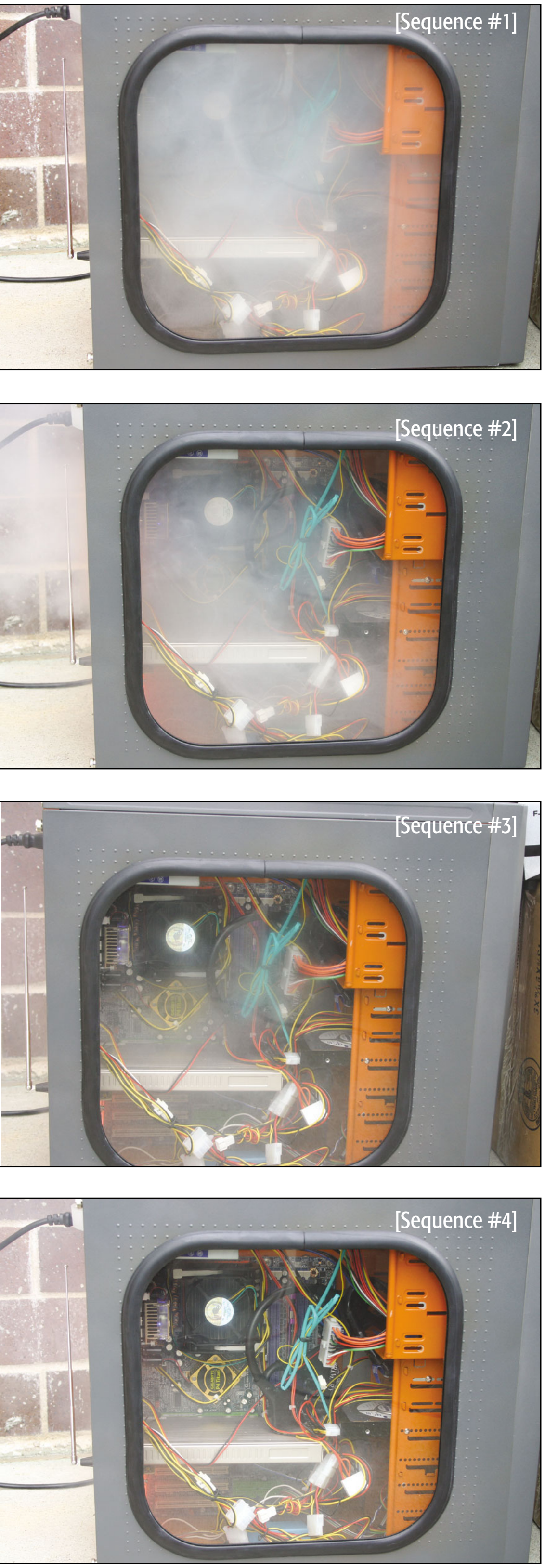
We spoke with lead technician William Tiu at Vantec about the CFM ratings of case fans. A third party tests the CFM of Vantec's fans using a CFM thermo-anemometer, which can measure the air velocity of the individual fan with a sensor that looks like a fan. "The velocity is then used, in combination with area of the air output, to calculate the CFM."

Don't underestimate the significance of the case fan.

A simple calculation can tell us roughly how many times per minute the fans exchange the air inside our case (assuming a 1:1 intake to exhaust ratio that offers no turbulence). First we must find the cubic feet of air our case occupies. Our midtower case measured 16 inches high x 7.25 inches wide x 18 inches deep, which encloses approximately 1.21 cubic feet of air (not accounting for the displacement of air by the components inside the case). Now we can divide the CFM of our case fans by the 1.21 cubic feet of air we need to move. Using this formula, a single 30CFM fan will exchange the air in our case approximately 24.8 times per minute. With the power supply fan and multiple intake and exhaust fans, this number can even reflect multiple exchanges per second. For instance, a case fitted with two 40CFM intake fans, one 40CFM exhaust fan and a 40CFM power supply (exhaust) fan can exchange the air in the case 132.2 times a minute or approximately 2.2 times a second (160CFM total divided by 1.21 cubic feet of air in the case divided by 60 seconds in a minute [60/1.21 = 132.2 times a minute]; to find the number of times per second, divide by 60 [132.2/60 = 2.20 times per second]; to find the total amount of air moving per sec multiply by the air volume of the case [2.20x1.21 = 2.66 cubic feet per second, which checks out because it also equals 160CFM/60 sec]). Now, fans of fans have a spiffy new statistic they can brag about.

According to Rahul Sood, president and CTO of VoodooPC, there's no hard-and-fast rule for engineering airflow for every PC; "Some cases are fine with no exhaust and one or two intakes, some the other way around." It all depends on the component layout and the path of the airflow. If your case accumulates dust, you might consider configuring your case with intake fans at a higher total CFM than your exhaust fans (including the power supply fan), which increases the air pressure inside the case, and as a result keeps dust at a minimum.

Smoke test. The smoke test is a good way to engineer the airflow with respect to your components. The smoke test works best with a windowed case so you can watch the flow of air when the fans are turned on. With the PC off, we positioned our Chauvet F-650 Hurricane Pro fog machine so that it blew smoke into an open drive bay. The smoke represents heat inside our case. When our windowed case was filled with smoke, we pressed the power button and watched as the air exchanged in seconds. If you perform this test on your own, take note of where the smoke exits from your PC. If very little smoke appears from an exhaust fan, you may want to reposition it, or flip it to make it an intake fan. If you notice areas where smoke seems to linger, you may want to position an exhaust fan nearby to increase the air movement in that area.



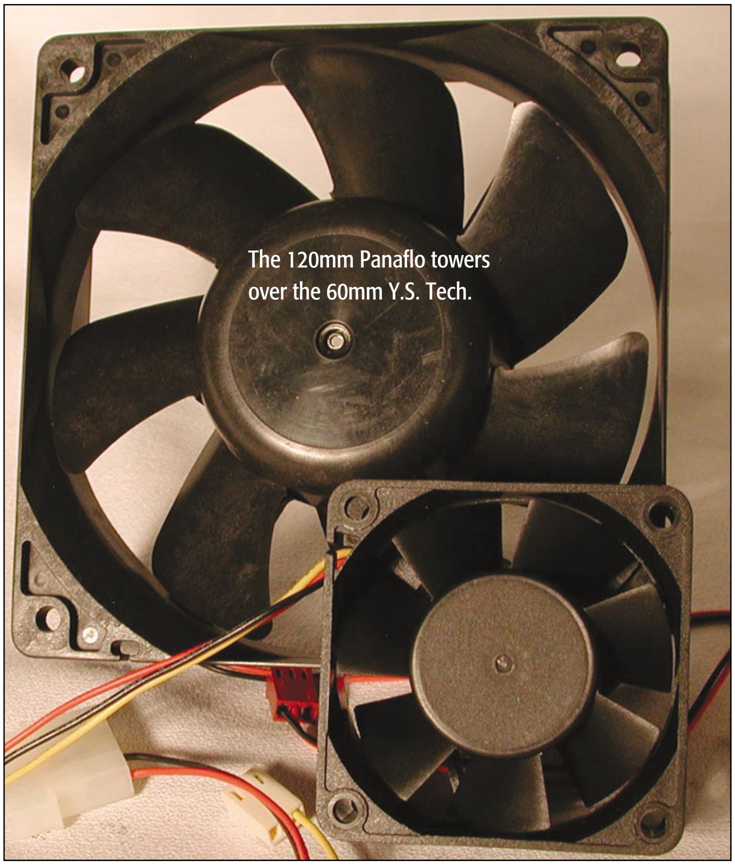
With the fans running, we noticed that smoke seemed to linger near the graphics card.

dB. One of the tradeoffs between fans over other active- and passive-cooling options is noise. Noise output is measured in bels with regard to the human hearing range. A decibel (expressed dB) is one-tenth of a bel of amplitude per unit area. The dB rating on a fan comes from the noise it generates at its highest rpm. Vantec's William Tiu said the dB rating for Vantec's fans is measured at a distance of approximately 2 feet. The sound sensors are positioned at the intake side of the fan because the wind noise from the exhaust side would produce a significantly higher reading. William Tiu also warned that the listed dB ratings are a measurement of the isolated fan; however, when you install a fan in a case, vibration can increase the total noise output. You can expect a typical PC to generate between 35dBs and 50dBs from the combined noise of the case fans, power supply fan, heatsink fan, optical drives, graphics card fan, and hard drive. Typically lower dB rated fans are less powerful and push significantly less air, but on the other hand, more powerful fans can be deafening.

The World Health Organization suggests that people can work comfortably with 35dBs of ambient noise. At 45dBs of background noise, the average person cannot sleep.

85dBs for prolonged periods will result in hearing loss. You might think you're hardcore enough to endure a noisy fan, but research suggests excessive noise can lead to irritability, heartburn, indigestion, ulcers, high blood pressure, and even heart disease.

Sleeve or ball bearings. Manufacturers and consumer groups generally agree that ball-bearing fans generate more noise than sleeve-bearing fans. Ball-bearing fans also have more moving parts than sleeve-bearing configurations. In a high-heat environment, however, a single ball-bearing fan will typically last longer than a sleeve-bearing fan, and dual ball-bearing fans can last significantly longer. In cool environments, the life expectancy of both bearing types is roughly the same. When choosing between fans with different bearing



The 120mm Panaflo towers over the 60mm Y.S. Tech.

types, consider the environment inside your case and your tolerance for noise.

Fan sizes. Fans come in a variety of sizes, from the tiny 20mm fan only suitable for cooling small areas, to the massive 120mm fans that are approximately the diameter of a CD. Because of their size, 120mm fans are more difficult to place in a PC. We mounted our 120mm test fans to the top panel of our case and they fit snugly between the CD-ROM drive and the power supply unit. Some optical drives were actually too long to fit in the top drive bay because of the fan. The most common fan size is 80mm, and the majority of the fans we tested were this size. Most computer cases come with screw holes positioned for 80mm fans. The advantage of 80mm fans is that they're large enough to move plenty of air without having to rotate at excessive velocities, which keeps the fan's power needs in check and minimizes noise output.

Typically, fan diameter and rpm (rotation per minute) numbers are inversely proportional, with smaller fans having to spin faster to move air, and larger fans able to push the same amount of air at a lower rpm.

The Best Blowers

For our roundup, we bought and tested 23 fans, ranking them in several categories depending on their features and performance.

Quietest. If your current fans drone like the engines of a B-52 bomber, maybe it's time to invest in a quieter method of air exchange. As discussed earlier, fan noise is almost directly proportionate to the amount of air the fan can move. For this reason, most of the top 10 quietest fans are also the least powerful. But if you don't need the extra power and prefer to hear the sound of your hard drive, then look to Vantec's Stealth or either of the AeroCool fans we tested. The two fans from AeroCool operated at 20dB, which is equal to just slightly louder than the rustle of a leaf. Though quieter than a whisper, Vantec's Stealth (also tied for the top spot with 20dB of noise output) is only capable of a measly 12CFM of air movement. The Zalman ZM-F1, ranked fourth, features a unique silencer in the form of a pass-through cable with a resistor that cuts the power from 12V down to 5.5V. The net result is a 20dB noise output at 1,300rpm. If you're looking for a relatively silent case fan that still pumps the heat, try the 120mm Thermaltake Thunderblade, which ranked fifth in our quietest list with 21dB.

We noticed that eight out of the top 10 quietest fans were sleeve-bearing types, while the remaining two had ball bearings. When looking for a quiet fan, anything that lists the decibel range between 20 and 30dB will be fairly noiseless.

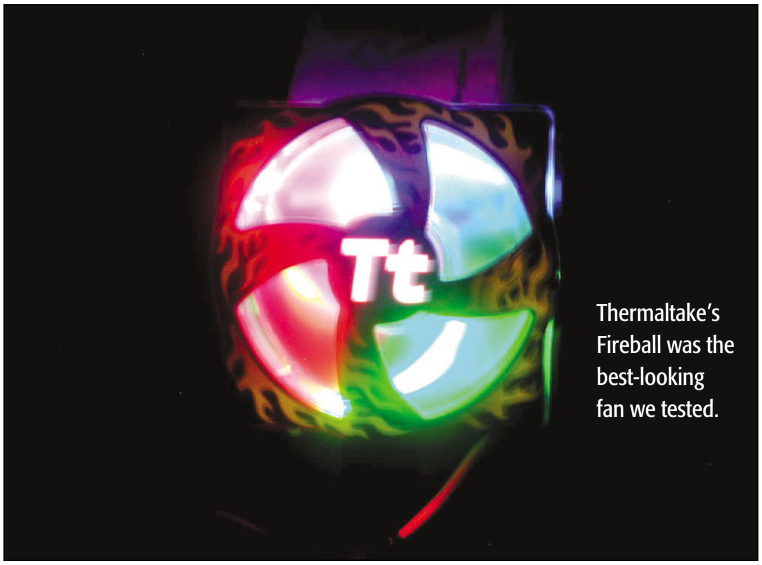
Most powerful. Throwing caution to the wind, we chose our top 10 most powerful fans. At the top of that list is the

The Taming Of The Fan

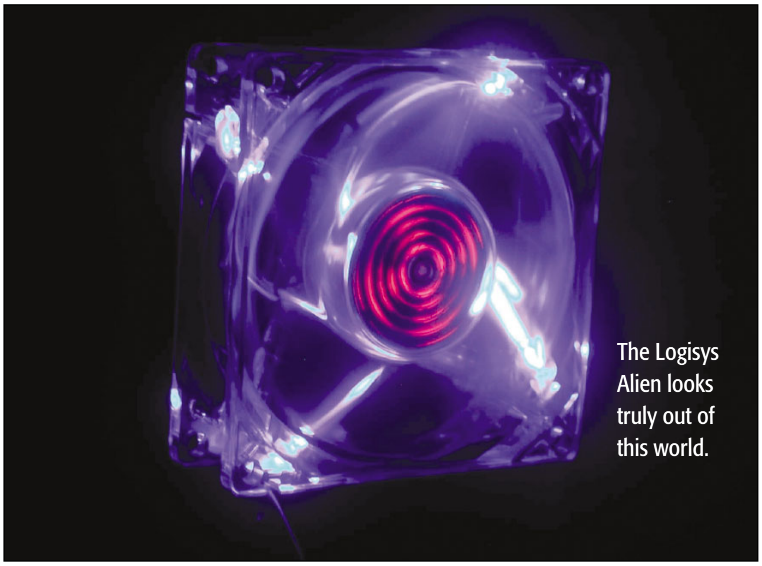
Once you have your fans figured out, it's time to start thinking about controlling the flow. Fan controllers are a must for overclockers who require extreme aircooling but don't want to live with the extreme noise of high output fans. Fan controllers vary from a basic knob for manual speed control to multiple temperature-sensitive fan triggers with digital readouts and heat alarms. We tested two fan controllers to manage the airflow in our case.

The Nexus. The Nexus, from Vantec, is a four-channel fan controller that fits into a standard 3.5-inch drive bay and is available with a silver or flat-black finish. The kit includes four 3-pin/4-pin fan connectors, a power connector, and four mounting screws. Although a simple diagram on the back of the box served as the instructions, installation was a breeze. The four connectors on the rear of the unit are labeled 1 through 4 to match with the corresponding knobs. The power cable and the fan connection cables are all clearly labeled. The extended aluminum housing fits past the extra-deep front panel of our case, which is more than we could say for the SilverStone control panel (see main article text). Each of the fan speed knobs is backlit with a blue LED. The four channels were enough to manage every fan in our case (not counting our PSU fan). The smoke test showed us that we were getting very little airflow below the video card, so we adjusted the fan speed to its maximum output. Our 120mm fan was also pulling plenty of air so we decreased its speed to cut down on the excess noise. Our two exhaust fans in the back of our case were working well at medium output.

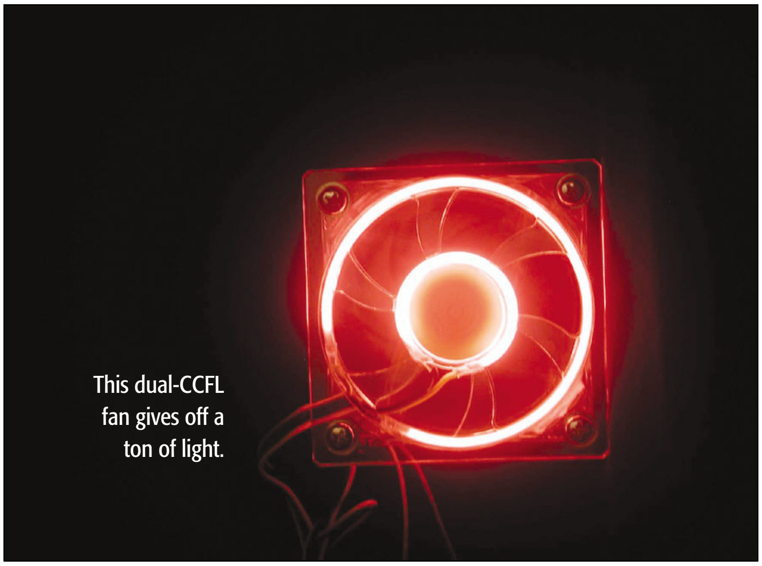
The Ultimate Controller. Enermax's Ultimate Controller has all the bells and whistles, literally. This four-channel controller fits into a standard 5.25-inch drive bay, but if you're running low on room in your midtower, you can use the included kit to mount a hard drive behind the controller. The aluminum-housed unit comes with interchangeable black and silver faceplates and has green and blue lights for the knobs. The backlit display also changes between blue and green with the push of a button. The beefy instruction manual offers installation tips in seven different languages, but the portion in English is only barely so. At one point the manual warns, "please contact your dealer if the problem persistent continuity." Even so, the Ultimate Controller went in easily. Each fan connector is labeled for the corresponding fan knob and the 4-pin Molex connector for the power supply is unmistakable. We positioned the four temperature sensors at strategic points within our case, one near the CPU heatsink, one on the hard drive, one in-between the RAM modules and another at a neutral point in the case to measure the overall temperature. You can adjust the overheat temperature for each sensor so that if the sensor reads a temperature above your designated limit, an alarm will sound. The controller also has a fan fail alarm that goes off in the event that one of the fans stops working. In both cases the alarm is diminutive and sounds like a digital watch alarm, gently reminding you that your processor is about to fry itself into a blob on your motherboard. The unit offered plenty of control over our fan speeds, and the simplified controls and bold interface make this complex controller fun to use. ▲



Thermaltake's Fireball was the best-looking fan we tested.



The Logisys Alien looks truly out of this world.



This dual-CCFL fan gives off a ton of light.

ever-popular 92mm Vantec Tornado, which is capable of moving 119CFM, or roughly 2 cubic feet of air per second. Power purists hardly bat an eye at the thundering 56dB of noise output, which is approximately equal to a moderate conversation. If you're not interested in fighting to be heard above the Tornado, the SilverStone FMC3XW system delivers a cool 103.44CFM at a less intrusive 44dB. If the noise output at 3,000rpm is still too much, you can adjust the SilverStone fan with the included (and ill-fitting) 3.5-inch bay speed controller, which can bring the noise output down to 17dB, which is even quieter than our most silent fans from AeroCool and Vantec. The 120mm Panaflo (screws not included), which is 38mm deep and by far the largest fan we tested, placed third on our most powerful list with an 86.5CFM rating. Rated at 35dB, the Panaflo, with its unique Hydro Wave bearing system, is the quietest system among the top four most powerful fans we encountered. The Thermaltake Thunderblade rounds out our top five with a 78CFM rating at a quiet 21dB of noise output. The only 80mm fan to make our most powerful list was the Ultra-Cool UC-9FBC, which ranked eighth with 48.71CFM. If you're looking for some serious movement from a small package, check out the 60mm Y.S. Tech High Output NFD1260259B-2F, which pushes 40CFM. But don't judge a fan by its diameter; Y.S. Tech's High Output fan has a noise output rating of 48dB, making it our second loudest fan, and at 6,800rpm, it's no wonder this thing is noisy.

Here, eight of the top 10 most powerful fans were ball-bearing types, with Panaflo's Hydro Wave bearing and the Thunderblade's sleeve bearing rounding out the list. Although the Thunderblade was the lone sleeve-bearing fan, it was the quietest of the heavy pushers.

Best looking. Fans are some of the few components of a PC that visibly move, and as a result the aesthetic possibilities are many. Some of our judgments about the best-looking fans are based on quantifiable observations, such as CCFL elements are brighter than

The Vantec Nexus feels right at home next to our floppy drive.

Enermax's Ultimate Controller makes the highly functional, highly fashionable.

LEDs, and more LEDs are better than fewer. Some of our conclusions, however, are based solely on personal opinion. For instance, we think flashing LEDs can be annoying, and nothing kills the fun at a LAN party faster than people lapsing into seizures during a heated deathmatch. Only you know what looks best in your case, so take our list with a grain of salt.

The top three best-looking fans we tested were all very impressive, and picking a clear winner was difficult. In the end, though, we settled on the 80mm Thermaltake Fireball. This fan features three multicolored LEDs and a flashing, illuminated fireball grill, which nearly doubles the depth of the fan. The fan also comes equipped with a shut-off switch for the illuminated grill. A very close second on our list is the 80mm Logisys nine-LED Alien fan, which has four blue LEDs in the clear plastic frame and five more LEDs mounted on the hub. When the fan is spinning, the five hub LEDs provide an interesting circular light show. Third on our list is the 80mm Galaxy, with two sound-sensitive red CCFL. The fan also comes with switch that lets you adjust the sound sensitivity or disable the CCFL altogether. The four-LED AeroCool Chameleon landed at fourth place in our rankings because of the unique temperature-sensitive fan blades, which change from purple to pink as the fan warms up. AeroCool's Chameleon gets extra points for being the most practical of our best-looking fans. AeroCool also grabs the fifth spot on our list with the aluminum-framed fan with four red LEDs. We ranked Vantec's blue and green UV LED fan sixth. The bright UV LEDs negate the need for a blacklight and really light the case well. Sunbeam's red CCFL fan comes in at number seven. Thermaltake's Thunderblade, with its three flashing, color-shifting LEDs, is eighth, but the disco effect may quickly get old. The four-LED 120mm and 90mm Galaxy fans ranked ninth and tenth. The runner-up award goes to Evercool's sharp-looking 120mm aluminum fan, even though it lacked any lighting element (not everybody has a windowed case). CPU

by Andrew Leibman

Top Ten Most Powerful Fans

	Brand	Fan Model	Size (millimeters)	Max Airflow (CFM)	Noise (dB)	Speed (rpm)	Bearing Type	Voltage	Connector
1	**Vantec**	Tornado	92 x 92 x 38mm	119	56	4,800	Ball (2)	12	3-pin/4-pin
2	**SilverStone**	FMC3XW	120 x 120 x 25mm	103.44	44	3,000	Ball (2)	12	3-pin/4-pin
3	**Panasonic**	Panaflo FBA12G12M	120 x 120 x 38mm	86.5	35	2,100	Hydro Wave	12	3-pin
4	**Evercool**	AL12025	120 x 120 x 25mm	84.76	39	2,200	Ball (1)	12	3-pin/4-pin
5	**Thermaltake**	Thunderblade A1973	120 x 120 x 25mm	78	21	2,000	Sleeve	12	4-pin
6	**Galaxy**	Crystal LED GC124R1	120 x 120 x 25mm	69.15	39	2,400	Ball (1)	12	3-pin/4-pin
7	**Galaxy**	Crystal GC12UVB	120 x 120 x 25mm	69.15	39	2,400	Ball (1)	12	3-pin/4-pin
8	**Ultra-Cool**	UC-9FBC	80 x 80 x 25mm	48.71	29	2,400	Ball (1)	12	3-pin/4-pin
9	**Galaxy**	Crystal GC94R1	90 x 90 x 25mm	48	34	2,800	Ball (1)	12	3-pin/4-pin
10	**Y.S. Tech**	NFD1260259B-2F High Output	60 x 60 x 25mm	40	48	6,800	Ball (1)	12	3-pin/4-pin

KEEP YOUR COOL

Don't Let Your PC's Temp Get Out Of Control

Although your computer's case isn't impenetrable, it generally protects your PC from most potential system-destroyers, including spilled liquids, dust, and curious children. Unfortunately, your system produces vast quantities of its own worst enemy: heat. In fact, the CPU generates so much heat that if it runs for even a few seconds without touching a cooling device, such as a heatsink or waterblock, the processor will destroy itself. And to make matters worse, your case, defending the system against outside threats, traps the heat inside. Custom system builders have a variety of cooling devices at their disposal, including heatsinks and watercooling units, but most rely on case fans and heatsink fans, which suck out the heat and breathe fresh air into your simmering system.

But case fans may not cool the entire chassis evenly, especially if you overclock certain components or if tangled cables disrupt the system's airflow. If heat threatens your computer's precious guts, you'll need to pinpoint dangerously hot air pockets, which means you'll need a temperature gauge that measures not just your PC's overall temp, but the temperature in specific locations. Enter the removable, multiple-sensor temperature gauge, a device that just might save your PC.

Time To Fill Another Drive Bay

If you've searched online retailers for PC temperature gauges, you already know that many gauges have the same basic characteristics: flat or bulbous sensors; small, black-and-white LCD's; external buttons or dials; and 5.25-inch wide bodies that slide snugly into one of your case's free optical drive bays. To lure users otherwise unwilling to sacrifice a drive bay, some manufacturers add hard drive mounts and fans. The drive sits just behind the device's front panel. Some new temperature gauges even have USB and FireWire ports.

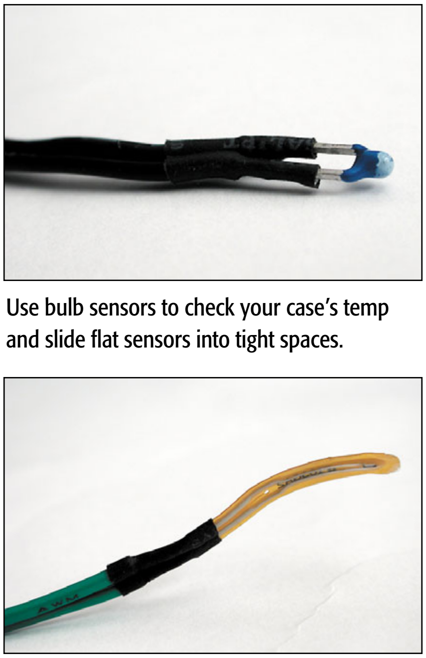
The LCD displays the thermal sensor's temperature reading. MacPower's Digital Doc 5+ ($52; www.macpower.com.tw) and the Vantec Nexus ($33; www.vantecusa.com), for example, each have a tiny LCD that sits next to the device's controls. Because the Digital Doc 5+'s LCD is so small, it automatically cycles through the sensor's readings, displaying one temperature at a time. Other devices, such as the FrozenCPU.com Lian-Li Dual Bezel Gauge ($32; www.frozencpu.com), trade control buttons and features for multiple displays. New cases also often have a built-in LCD and single temperature sensor. If you're handy with a Dremel and want to measure only one location's temperature, you can save drive bay space by adding a small, single-sensor, LCD-only temperature gauge, such as the Global WIN CompuNurse ($12; www.globalwinusa.com). Most temperature gauges display sensor readings in degrees Celsius, but users who prefer Fahrenheit can configure some high-end gauges to display in Fahrenheit.

Temperature gauges that have few sensors and options are inexpensive, but they generally lack two important features that make high-end gauges attractive to heat-and-noise-conscious users: high temperature alerts and fan control.

Most fans spin at a single, preset speed whether the system is idle or under a full load. If you aren't having heat-related problems and want to reduce your system's fan noise, you can use a high-end temperature gauge that includes a rheobus to lower fan speeds. This type of temperature gauge has several fan connectors and potentiometers that let you adjust the voltage flowing to individual fans. When you lower the fan's voltage, the fan slows. Thanks to the control feature, you can lower your fans while your system is idle and crank them back up when your system takes on heavy loads. The Turbo Case Aspire 609 Fan Master ($28; www.newegg.com), for example, includes several dials that let you manually control individual fan speeds.

Some gauges can automatically control fans based on preset temperature values. By letting the gauge automatically adjust the settings, you can ensure that all of your system's fans are on when you stress your computer. Although the Digital Doc 5+ doesn't let you adjust fan speeds, it can power off individual fans and then power them on again when their related sensors register unacceptable temperatures, which means you can fire up a game or other intensive software without manually adjusting your fans. By turning off unneeded fans, the Digital Doc 5+ reduces your system's noise.

Multisensor temperature gauges generally have two types of diodes: bulb and flat. Although both sensors are fragile, the bulb diode is the hardier of the two. You can suspend a bulb sensor inside the case to monitor the ambient temperature, or you can use thermal tape to attach it to a flat surface, such as a chipset or hard drive.


Use bulb sensors to check your case's temp and slide flat sensors into tight spaces.

However, the bulb's shape means you can't place it in particularly tight locations, such as the gap between a heatsink and a processor. Flat sensors easily attach to flat surfaces and fit into the small gaps bulb sensors can't reach, but the sensors are very fragile. You can easily break a flat sensor by bending it or simply bumping it into an object.

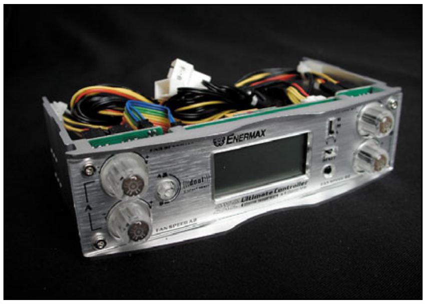
Don't Put This Under Your Tongue

Determine which locations you plan to monitor and what bulb types you'll need before you buy a temperature gauge, as the number and type of sensor varies from gauge to gauge. For example, MacPower put six bulb sensors and two flat sensors into the Digital Doc 5, but put six flat sensors and two bulb sensors into the Digital Doc 5+. Cooler Master's Aerogate II ALD-V02 ($46; www.coolermaster.com), on the other hand, has four flat sensors.

If you're not sure where to place your temperature gauge's sensors, aim for three of your system's hottest components: the hard drive, the processor, and the motherboard chipset. You may also want to monitor your system's ambient temperature to make sure your system maintains a consistent airflow. An AMD representative suggested suspending a bulb sensor in front of the heatsink fan to monitor the temperature of the air flowing toward the heatsink.

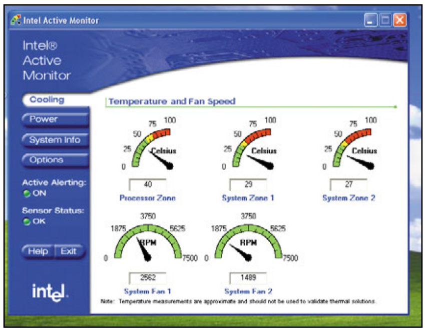
You can attach either type of diode to a hard drive by running thermal tape over it. Some manufacturers suggest particular locations that let the sensor accurately read the drive's temperature. Seagate, for example, recommends placing the sensor near the back end (opposite the power and data connectors) of a Barracuda. If you're not sure where to place the sensor, check your drive's manual. Motherboard chipsets generally sport heatsinks or heatsink/fan combos, which means you'll have trouble attaching either type of diode directly to the core top of the chipset.

Placing a sensor near your CPU is tricky. You can't put the sensor directly on the core because it will block the heatsink from contacting the entire core surface. As a result, processors generally don't make great candidates for external sensors. However, AMD Athlon XP processors have a raised core and four small pads that create a gap between the heatsink and the body of the processor. The AMD representative told us that a user should be able to slide a flat sensor into the gap without trouble. If you place a sensor in this gap, keep in mind that although the sensor itself is flat, its cable is not. If you wedge the cable under the heatsink, you may break the heatsink's contact with the processor's core.



Some Temperature gauges, such as this Enermax UC-A8FATR4 ($36; www.maxpoint.com), can let you adjust fan speeds to lower your PC's noise.

On the other hand, AMD's new Athlon 64 and Athlon 64 FX series processors have a small case that covers the top of the processor, including the processor core. As a result, these processors (and Intel P4 processors, which have similar designs) don't have the gap that Athlon XP's offer. You can approximate the CPU's temp by placing the sensor in between the heatsink's fins. Once you slip the sensor in between the fins, angle it downwards to push it as close to the bottom center of the heatsink as possible.



Note: Temperature measurements are approximate and should not be used to validate thermal solutions.

If you have an Intel-based motherboard, you can use the Windows-friendly Intel Active Monitor to keep tabs on the processor's temp.

If you're short on drive bays or simply don't want to buy a temperature gauge, you can check your processor's temperature in your system's BIOS. Most processors have on-die diodes that work with the motherboard to calculate the processor's temperature. You can view this temperature in the PC Health section of your BIOS, but your system won't be running under a full load. If you want to check the on-die diode temp readings from Windows, you'll need to install a third-party application. Some motherboard applications have overclocking software that displays processor temps, and Intel offers Active Monitor, which is a free utility that uses the on-die diode to report your processor's temperature. You can run it at any time, which means you can keep an eye on the processor's temp while stressing your system. CPU

Pushing The Limit

Manufacturers assign processors a maximum temperature limit to help system builders avoid melting the precious cores. Because AMD Athlon XP processors don't have the thermal cases that protect Athlon 64 and Intel P4 processors, AMD can put small labels on the body of the processor without affecting performance. To find your Athlon XP's max temp, simply look at the Ordering Part Number label and then find the third character from the left, which will be an S, T, or V. S = 95 degrees Celsius, T = 90 C, and V = 85 C.

Intel recommends a 40 C maximum CPU case temperature for 423-pin P4's and 478-pin P4's at or below 2.8GHz. Always the detail-oriented chipmaker, Intel recommends a 38 C maximum temperature for 478-pin P4's to 3.4GHz. We spoke with an Intel engineer who suggested that P4 owners use 64 C as maximum temperature when monitoring the processor's temp via the Intel Active Monitor.

Individual hard drive families have different temps. If you don't have your drive's manual, you can generally find the drive's max temp by visiting the manufacturer's Web site and browsing the drive's specifications. ▲

by Joshua Gulick

CHILL CHAT

Keep The Heat Down With These Handy Tips

Now that computers are getting faster, more powerful, and smaller, heat is becoming more and more of a problem. It's especially vexing if you're going to try to overclock your machine. If your CPU gets too hot, all of the high-priced mods you've spent years accumulating will be worth as much as the silicon in the bottom of your fish tank. Fortunately for you and your nontechno-savvy goldfish, there are alternatives to melting down $2,500 worth of hardware: heat transfer fins, thermal grease, fans, and water-based cooling systems. I'm going to discuss some of the more popular options and maybe even point you in the direction of some new ideas.

Sink The Heat

The function of the heatsink in your computer is similar to your air conditioner or refrigerator. A thermally conductive material (copper is popular, and aluminum works, too) is mounted flush to the heat source. In order to maintain the small size constraints on today's modern machines, fins or pins are added to the material. The math is complex, and I won't get into it here (I could—those degrees in engineering have to be good for something), but the fins are intended to increase the surface area of the heatsink while keeping the footprint small.

If you've got an outrageously modified PC and can't find an off-the-shelf heatsink for your application, you can also purchase a used heatsink from a local supply store and cut it to whatever size you want. This is also a possibility if you're trying to remove heat from an overworked video card. If you're going to try to make your own, you've got to be careful to keep the back side (the side without the fins) as clean and scratch-free as possible because this is the only surface to take heat from the chipset. I wouldn't recommend this approach unless you've got the patience to work slowly and carefully to ensure an undamaged interface and burr-free edges, but if you've got no choice, it is a viable alternative.

After you've got your heatsink chosen (or manufactured), you need to attach it to the chipset you're trying to cool. A very drastic measure would be to use a metallic-infused epoxy to affix your heatsink directly to your chipset. You should note that this is a fairly radical move and should not be undertaken lightly; if you glue your heatsink to the chipset, it's there for good. You should know what you're doing before you try it and be certain that it will be worth the extra degree or two of cooling power you'll get. If you're not in the mood to risk that much, you will still need to attach the heatsink to the chipset using some kind of scaffolding in conjunction with some kind of TIM (thermal interface material).

Grease It

TIM is one of any number of substances in either paste, liquid, stick, pad, or foil form that mates your heatsink to the chipset you're trying to cool. The form may differ, but in each case the idea is to provide a conductive interface between the chipset and the heatsink and reduce the amount of air between the two because air is a poor conductor of heat. For the most part, there is very little difference between the thermal performance of various types of TIMs, usually only a couple of degrees. It really all comes down to your application and what measure of inconvenience you're willing to put up with (For more information on TIMs, see our "Working With Grease" article on page 142).

In the past greases came in plastic or foil tubes and were applied with a putty knife. Though this is still the case with some products, many now come in plastic syringes, making application a little simpler. Greases come as nonmetallics or can contain aluminum or silver. The problem with the greases is that the performance may decrease over time due to the grease drying out or the migration of the material, which leaves gaps in the interface. They are also messy and, in most cases, electrically conductive, so you must be careful to remove excess grease so you don't create a short and eliminate the need to cool your computer, as it will be nothing more than a charred pile of plastic and heavy metals.

Thermally conductive tapes and thermally conductive elastomers work well to provide the thermal conductivity of grease but will not flow freely enough to move past the edges of the heatsink/chipset interface. Thermally conductive elastomers are silicone pads filled with thermally conductive ceramic particles, often reinforced with woven glass fiber or dielectric film for added strength. Thermally conductive tapes are double-sided, pressure-sensitive films impregnated with enough ceramic powder to provide thermal and electronic conductivity.

It's Just A Phase

PCM (phase-change materials) are designed to alleviate the problems associated with greases. A PCM is a solid at room temperature, but softens or even liquefies at the operating temperatures of your CPU. The change of phase will help draw some of the excess heat out of the chipset but can only be used in conjunction with a cooling fan because the PCM will only remove heat until it is completely melted and has reached equilibrium with the temperature of your chipset.

Now that you've gotten the heat from the chipset into the heatsink, you've still got to get it out of the case. The best way to accomplish this would be to leave the case completely open and surround it with fans. Unfortunately, leaving your case open to airflow also opens it up to dust, which is almost as bad for components as heat. This means that you're going to need as much air flowing via fans as possible. Again you will run into space constraints, with the added hassle of having to place the fans so that air flows over your high-risk components, such as your processor, disk drives, and video cards. The trick is to find an open area on your computer's case (at least one—two or more on opposite sides is better if you've got the space) and install cooling fans. Again, the bigger the better, but an 80mm fan or two will work wonders for heat removal. It's a fairly simple procedure, assuming you can get your hands on a hole saw and a drill. A search of the internet can yield graphics, but you basically cut a round hole in the case with the hole saw, transfer the hole locations from your fan (and grille if you're so inclined), and drill them through the case. If dust is a problem, abrasive pads used for cleaning dishes work well as filters on the inside of the grille. Then, all you've got to do is install the fan with the included hardware and run the power cables to your power supply. The sky's the limit—you can get as fancy or down-and-dirty as you want.

Going Further

Finally—and this is for those of you that are serious about heat removal—there's watercooling. Watercoolers work on the same principles as aircooling, but water has a higher specific heat than air, so it can remove more heat with less mass. That's mass of fluid, people, not equipment. The downside of watercooling is that you need an enclosed system to keep the water from leaking, and you need pumps, heat exchangers, and all manner of other mechanisms to achieve the same effect as a fan and a heatsink.

If you're really determined to use watercooling, there are some off-the-shelf systems that will work for most chipsets and require little to no modification. There are some other factors to consider, however. If you're going to use watercooling, I strongly recommended that you not use only deionized (distilled) water. DI water has a tendency to pick up metal ions (aluminum) which can cause corrosion and damage to your system. You should use a small amount of antifreeze in addition to the good old H2O. This will raise the ion content of the water, give you a couple extra degrees of specific heat, and keep your aluminum and copper parts intact. You should also consider some type of biocide to keep your system free of microorganisms, which can clog the system and foul the heat transfer surfaces. Addition of a commercial algicide available through laboratory suppliers will help keep your water germ-free and smelling fresh for months.

Hopefully these tips will steer you in the right direction toward keeping your cool new PC cool and comfortable.

by David Miller

Top Picks

Nanotherm Ice (www.nanotherm.com) is, in my opinion, one of the best thermal greases on the market. It is nonhazardous and chemically inert thanks to the USDA-approved "food grade" lubricants, and has high thermal conductivity and low thermal resistance because of the nanocomposite thermal materials. It will remove the heat sufficiently and, thanks to its viscous nature, it will fill the imperfections in your heatsink and chipset but will not flow away while you're trying to apply it with its included plastic syringe.

The Zalman Reserator 1 (www.zalmanusa.com) is not only stylish but will help keep PC noise to a minimum. Its electric-brushed blue exterior houses one of the most innovative watercooling systems to date. Its internal motor circulates water (that you provide) through the included AMD or Intel water block almost noiselessly. The included plumbing does not require a major overhaul of your system for integration. It does not use an external fan but will remove sufficient heat depending on the placement of the heat exchange tower. It will keep both the noise and temperature of your PC down. ▲

Nanotherm Ice

Zalman Reserator

PROJECT METROPOLIS

How Artist Paul Capello Built His Latest Modding Masterpiece

Man is still the most extraordinary computer of all.

—John F. Kennedy

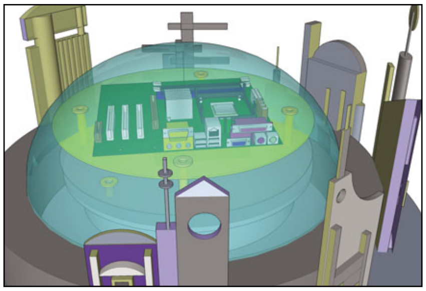
The Inspiration

Like most artists, I have a hard time sleeping. A cup of strong coffee, about an hour old, sits on my desk untouched. It's almost 4 a.m., and the street outside my window in Brooklyn, NY, is quiet except for the rustling leaves of a giant Sycamore. The sturdy trunk of the tree rises from the concrete sidewalk and the patch of soil it was planted in many years ago. I turn back to the computer monitor and the blank canvas of my 3D-sketching program, but there's no inspiration to be found there, in the bright glow of the screen.

I've been asked to create a display for VIA Technologies and base it on their new Mini-ITX motherboard. I had less than two weeks to complete the project and have it shipped to Hanover, Germany for the CEBIT 2004 convention. I'm often asked where I find the inspiration for the case mods I create, and it's the one question that is very difficult to answer. To wit, I knew where it wouldn't come from: staring at this stupid monitor. Frustrated, I switched it off and turned my attention back to the window and the tree-lined street outside. After several peaceful minutes, the relative tranquility was broken by the belching roar of an approaching sanitation truck, a noisy, man-made mammoth on its nocturnal forage for food.

The truck stopped in front of my apartment, and the familiar whine of its pneumatic compactor was like the earth-shaking growl of some prehistoric beast. These sounds, the leaves in the wind and that of the garbage truck, as different as Yin is from Yang, were both part of the living, breathing city in which I was raised. I closed the window against the din outside and slumped in my chair, rubbing my sleepless eyes. Some fresh air might do me good, and I took the now cold cup of coffee with me as I climbed the small ladder that leads to the roof of my two-story home. This neighborhood was built on Brooklyn's highest hill, appropriately named Sunset Park for its amazing view of (you guessed it) the setting sun. At night the view of Manhattan was also great, and it was there that I turned my attention. The skyline of New York, though forever changed, is still as breathtaking as ever. The buildings that made up all the peaks and valleys shimmered with twinkling light, and there was a barely perceptible hum that was the rhythm at the heart of it. It was the shapes of buildings against the dull white glow of the horizon that I watched for some time. The City. Manhattan. Gotham. Metropolis.

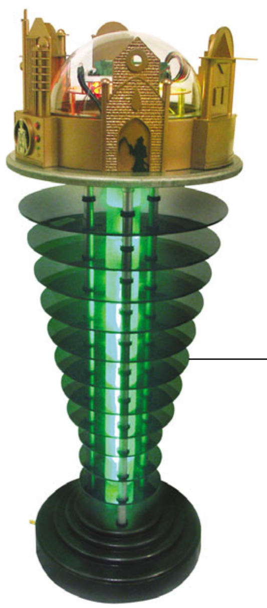
I was on to something. Back at my computer, I brought up the 3D program and began roughing out a city skyline comprised of simple buildings and silhouetted shapes. As I started adding extruded parts and more detail to the architecture of the buildings, they began to take on abstract shapes. In the 1927 silent film "Metropolis," director Fritz Lang shocked audiences with his vision of a future city built from the sweat and sacrifice of worker-slaves and ruled with an iron fist by the wealthy. In this film, the buildings that made up the city had a leading role: living, breathing elements as important as any other character. I remember seeing this film on TV as a kid, and again only a few years ago on the big screen, complete with a live orchestra. It was incredible.



The inspiration for project Metropolis was born from the 1927 Fritz Lang movie of the same name. Although the city from the movie didn't have a dome, this concept was used many times in sci-fi novels and film. The dome would also keep curious fingers and hands off of the Mini-ITX motherboard at the CEBIT show.

Project Planning

I now had the central theme of the project and a starting point from which to launch my ideas. My plan was to design a display around the hardware, and the Mini-ITX motherboard would be at its heart. I would construct a platform on which to mount the barely 7-inch square motherboard and fabricate buildings and architecture inspired by the film to create a miniature Metropolis skyline. My very first concept drawings had the



The pedestal for Metropolis became an integral part of the look and feel of the project. The 'tower of light" concept was inspired by the gadgets and gizmos a mad scientist might have.

platform for the city as a square shape, and it was only later, through the advice of a friend, that I made it round and added the clear acrylic dome. It's been my experience to let a concept simmer for a while before you jump in and begin a project. Like painting or sculpture, there is a point where the piece begins to "speak" to you, and it's at this stage where it's very important that you're all ears.

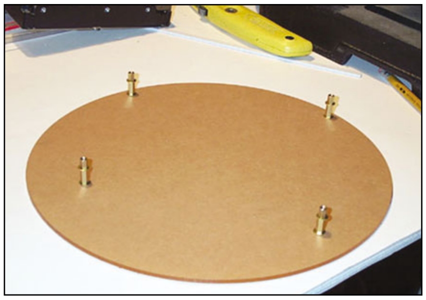
I knew from the beginning that this project wouldn't be a case mod in the "traditional" sense, where a stock computer enclosure was hacked, chopped, and otherwise modified from its original form. Because this (ahem) display was going to be presented as part of Via Technology's booth, it really had to stand out from the crowd if it was going to make an impression. It had to be a singular piece, able to stand on its own and not anchored to a table or desktop. The solution for this was to integrate a pedestal into the design. In this case, a pedestal would not work purely as a "stand" for the miniature city on top but rather had to be part of the sculpture as a whole. When designing pedestals for sculptures, one of the most important goals is to raise it up so that the artwork is brought to the proper viewing height. Whether that height is 4 inches or 4 feet depends on the sculpture itself.

The pedestal ultimately became an important part of this display, and a lot of thought was given to the materials and overall design. The pedestal couldn't overpower the sculpture on top, so creating a design that was solid and pillar-like was out of the question. Drawing on the influence of sci-fi movies and illustrations, I came up with the "tower of light" concept for the pedestal. When I began to sketch it out in my 3D program, it reminded me of a weird gadget that a mad scientist might have in his laboratory. Now that I had a clear direction to travel in, it was time to hit the road and begin construction on project Metropolis.

Construction Part 1

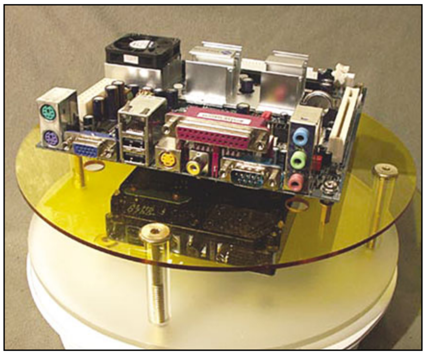
The Building Of A City

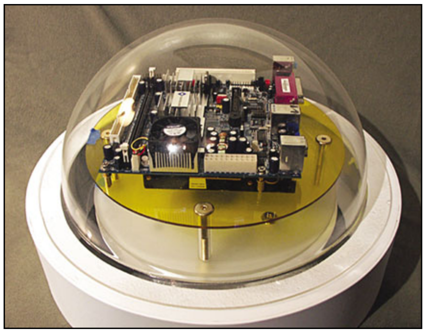
Before I could begin construction, I had to write up a shopping list of parts and supplies for the project. My first stop was the plastic supply store, where I browsed the aisles in search of suitable materials. As a master model builder, finding the right materials for a given project is fairly easy to do. If you're just starting out as a craftsperson, the single most important advice I can give is to experiment. As you become more familiar with materials and their properties, you'll have the knowledge and know-how to find just the right ones for your own projects. For me, that material is plastic. I can cut, shape, carve, and form just about anything from it.

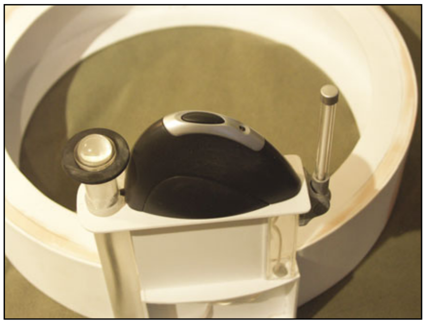

The motherboard and hard disk drive were both mounted to acrylic circles. The brass standoffs that come with stock PC cases were perfect for mounting the hardware.

For the platform, I chose precut acrylic and stock sheets of styrene. Plexiglas (methyl methacrylate) is a form of acrylic, and there are many brand names, compositions, and properties of acrylic available. Styrene (or polystyrene) is the same material that is used to manufacture plastic model kits and countless other items. The styrene I use comes in 2- x 3- foot sheets and in thickness from 0.040 inches to 0.080 inches. Unlike acrylic, which is fairly ridged, styrene can be formed and shaped pretty easily—perfect for making the round platform for the project. Both materials can be bonded with superglues such as Zap-a-Gap (cyanoacrylate adhesive) brand or solvent-based cements. The best place to find these materials and supplies would be a model railroading shop or hobby store.

The platform would become the structure that housed the parts for a functioning PC, and also a base to attach the various buildings. The small brass standoffs that are supplied with stock PC cases were used to mount the motherboard and

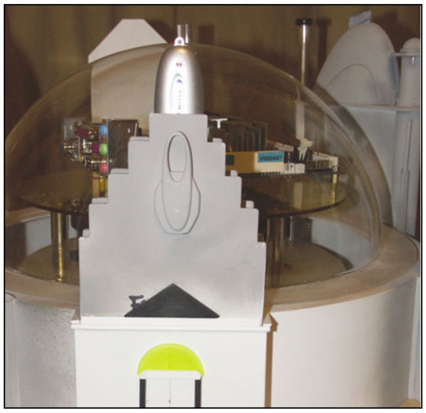

A short, hollow tube made from sheet styrene was created to hold the Mini-ITX power supply and all the wires and cables.

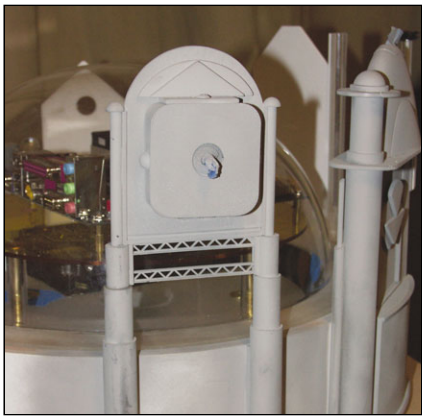

A second hollow tube was made, and this would become the base for mounting the six buildings that made up the "city." The acrylic hemisphere was an inexpensive item I found while shopping at the plastic supply store.

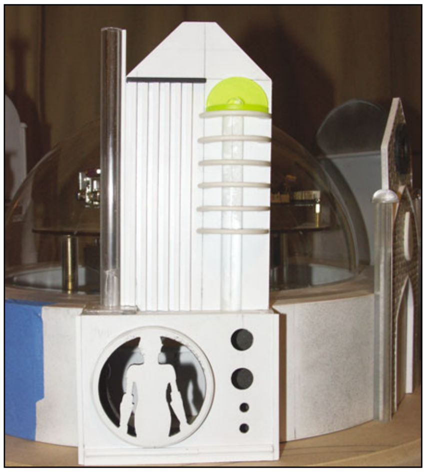

Functional parts of the PC were integrated into the design of the buildings. This wireless receiver for a mouse and keyboard became the top of the "Radio Tower."

hard disk drive to the acrylic circles. I installed two small cold-cathode lights under the motherboard, one red and one yellow, to create a nice warm glow under the dome. Next, I made a short tube from sheet styrene, and this would be mounted below the acrylic disks with 3-inch brass bolts as spacers. A second outer ring was formed with styrene, and this would become the mounting point for the buildings and clear dome. Speaking of the dome, this was an inexpensive stock part found at my local plastic supply store. Made from acrylic, it was optically clear and sturdy, complete with a ring that was perfect to use for bolting it down. By this time the drawings I made in the 3D program were forgotten and the project was starting to take a freeform path of creation.

The most enjoyable part of the project came when it was time to make the buildings of Metropolis. The project wasn't about making exact replicas of the buildings from the movie, so I relied on the impressions they each left me with in guiding their construction. An idea came to integrate some of the buildings into the functioning parts of the PC itself. The design of the "Radio Tower" building was conceived in part by shape of the Belkin wireless mouse and keyboard receiver that was built-in to it. A red 4-inch cold-cathode light from an auto supply store became the building's radio antenna. The aptly named "Uzbee Building" contained a removable USB pen drive that became the top of the top portion of the structure. The plastic shapes used to create the details of the buildings came from the architectural model parts that are sold at hobby stores. They might be hard to find near you, but doing a quick search on the Internet for brand names such as Evergreen Scale Models and Plastruct would find you stores to buy them online. All the professional model-building studios in Hollywood use these parts to create exact miniature replicas of buildings and structures for use in special effects. The sheet styrene I used for the larger parts of the buildings was very easily cut by first scoring the plastic with a hobby knife guided by a metal ruler or straightedge. The piece was then slightly bent by hand, and with a satisfying snap, the plastic was cleanly broken. Since the plastic stock was white, it was often hard to see the details in the buildings as I worked. To remedy this, I would lightly mist the completed sections with gray aerosol primer. Any fast-drying primer sold in auto supply stores is best, drying to the touch in only a few minutes. The paint created a nice contrast, and all those small details popped off of the buildings.


A removable USB pen drive was the inspiration for the "Uzbee Building." Inside the structure, I hot-glued a USB cable that would later be connected to the motherboard.


A battery-powered quartz mechanism from a thrift store became the central part of the working "Clock Tower."


The base of this building was made to house a 60mm intake fan and the power/reset buttons. The pattern for the "Robot Maria" fan grill was created in Photoshop, then cut from styrene on a scroll saw.

Central to the film was the 10-hour clock that workers in the bowels beneath Metropolis would base their day on. For this building, I integrated a battery-powered quartz mechanism ripped from a clock I purchased at a thrift store. When building case mods, you really need to keep an eye out for interesting parts to use. My favorite places to browse are the big home improvement stores with their countless aisles of parts and supplies that can be used in projects. I made yet another building to house the 60mm intake fan, power/reset buttons, and LED indicator lights.

For the fan grill, I wanted to create something special and decided to do a bit of cutting on my scroll saw. Using the image of the famous "robot Maria" from the film, I made a template in Photoshop and printed it out. This template was then mounted to a piece of styrene using spray adhesive. With my pattern in place, I carefully cut the silhouette shape from the plastic using a fine blade on the scroll saw. Small Riffler files came in handy for the fine finishing and carving of the shape. The paper pattern was then peeled off and the fan grill cleaned with a soft rag and mineral spirits to remove the adhesive. One of the nice qualities of styrene is how easy it is to carve and shape. Wet sanding with 600-grit paper removed any burs and rough edges, and the grill was ready for finishing.

A high-resolution color print of the Maria robot was then made on plain paper and carefully cut out with a hobby knife. This was then positioned and mounted to the fan grill with more spray adhesive and trimmed where necessary. I mixed up some clear five-minute epoxy, and with a small disposable foam brush, I gave the entire grill a nice coat of protective resin.

Construction Part 2

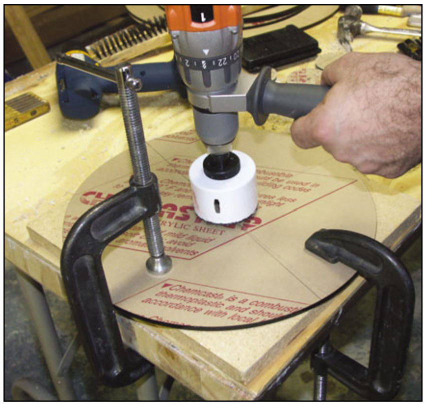
The Tower Of Light

Now that I had the six buildings completed and mounted to the platform, it was off to the workshop to build the pedestal. The design for the pedestal was simple yet elegant, and could be made in one afternoon. A center column and three smaller pipes would support acrylic discs of various sizes, giving a nice open look to the 4-foot tall pedestal. For the center column, I used a clear acrylic tube, 2.75 inches in diameter, which would later be frosted and illuminated from inside using cold-cathode fluorescent lights. Three lengths of aluminum conduit used for home electrical wiring served as the mounting points for the acrylic discs. For the top and base of the pedestal, MDF (medium-density fiberboard) would be cut into circles to compliment the round acrylic discs.

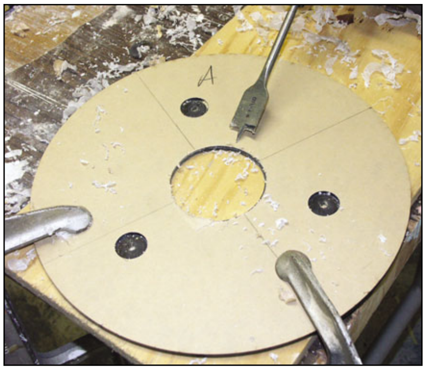
I had an entire sheet of 0.25-inch bronze translucent acrylic cut into 12 discs for me at the plastic shop. The sizes were in 1-inch increments from 10 to 22 inches in diameter. Each disk was clamped down to the worktable, and a 2.75-foot cut was made in the center with a hole saw. Next, I had to build a jig that would be a guide when drilling the three smaller holes for the aluminum conduit. For these pipes, a nice, sharp spade bit was used on the disks for a clean, 0.75-inch hole. Because the discs were laser cut at the plastic shop, very little cleaning was needed on the outside edge of each one, saving me precious time and energy.

For the top and base of the pedestal, circles were cut from MDF and given a clean edge with a router equipped with a round over bit. The threaded collars that came with the conduit were used to attach the pipes to the underside of the MDF top piece. The base of the pedestal would be home for the two

Translucent bronze discs were laser cut from acrylic at a plastic supply store. Looking back on the project, I should have had them cut all the holes, too.

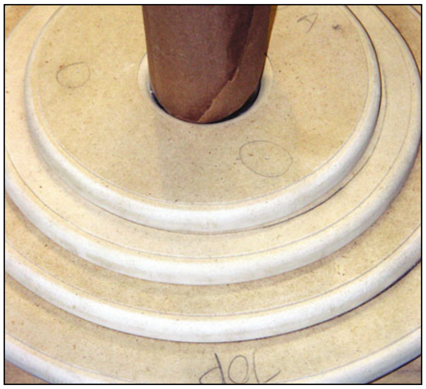


A 2.75-inch cutout was made in the center of each disc with a hole saw. Later, the disks would be mounted on a frosted acrylic tube of the same diameter.

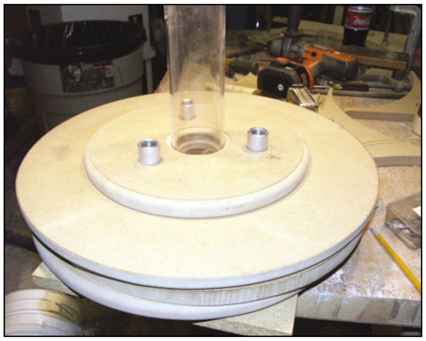


Holes for the conduit were made with a sharp, spade-type drill bit. Working slowly and carefully helps prevent costly mistakes.

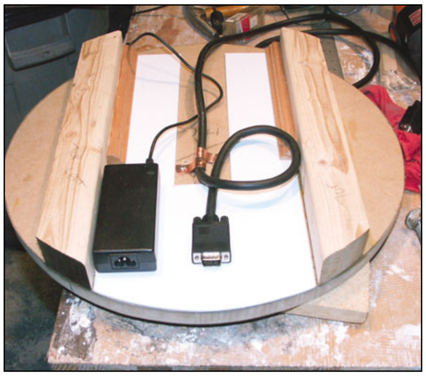
Circles made from MDF (medium-density fiberboard) were cut using a jigsaw. These parts would become the top and base of the pedestal.



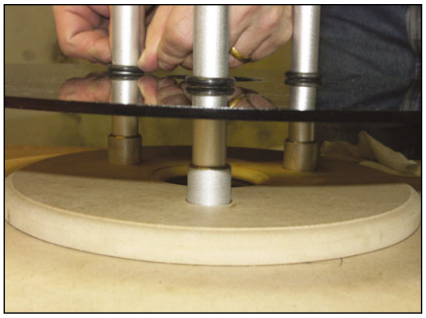
A round over bit and router was used to make a clean edge on the MDF circles.



The threaded collars that came with the conduit were used to attach them to the underside of the top piece. Holes were drilled in the MDF and the collars secured with epoxy.

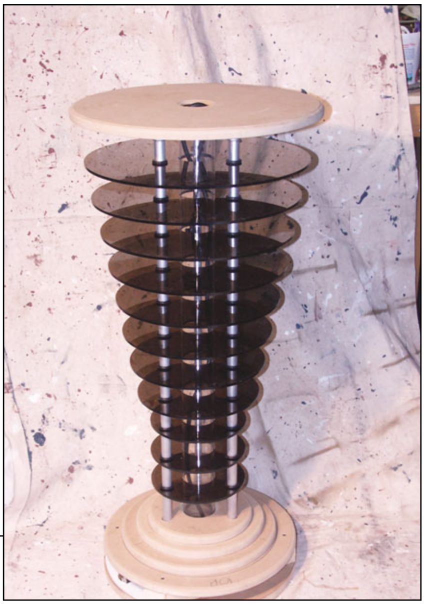


The base of the pedestal was used to house the power supplies and the VGA and audio connectors. These cables would later be snaked up the center tube.



Rubber o-rings were cleverly used to hold the acrylic discs in place. Each disk had six o-rings, three on top and three beneath.

power supply converters, as well as the VGA and audio connectors. I mounted these on a removable tray made from sheet styrene, in the event that they would need service or replacement at some point in the future. When all the parts were cut, it was time to assemble the pedestal piece by piece. It was my brother Luciano's idea to use rubber o-rings to hold the acrylic disks in place on the conduit. (It was such a brilliant idea, I only wished I thought of it myself.) Each disk was rather painstakingly measured and mounted on the pedestal, taking quite a bit longer than expected to get looking just right. Once the pedestal was completed, the time involved proved well worth it, and I could finally see the entire project coming together.



Once the disks were installed, the pedestal really began to take shape.

Construction Part 3

Putting It All Together

When I first placed the buildings on the pedestal, I knew that my rough measurements and calculations were right on, as the composition of the piece came together nicely. The next step was to come up with a suitable paint finish for the buildings and pedestal. My first thought was to use an antique copper kit on the buildings. The kit contained a bright copper spray paint and a can of brown acrylic for sponge stippling. I did a test on one of the buildings, and as it turned out, I didn't like the look of the faux antique finish at all. I did like the nice, bright copper color though, and decided to go with that.

For the pedestal top and base, I found this cool-looking, "hammered" bronze spray paint. When applied, chemicals in the paint would create dimples in the finish to simulate a rustic, hand-made look. MDF material is notoriously sponge-like, so several coats of primer were needed before applying the finishing coats of hammered bronze. In the end the copper buildings and dark bronze pedestal looked pretty good together.

Installing the remaining PC components was a bit of a challenge and took quite a bit of head scratching to get just right. Cables and wiring for the motherboard, switches, lights, and PSU had to be very neatly routed in order to keep things tidy inside the small confines of the buildings. Down the center of the pedestal and inside that frosted acrylic tube, I installed a length of 3/16-foot steel rod that would be used to mount the two green CCFL lights, the monitor cable, and wires for the PSU converters. It was a tight fit all around, but somehow it all worked out. It was time to fire this motherboard up and install an operating system.

It's A Wrap

Closing Thoughts On Project Metropolis

The first time I sparked up this display, I was pleased with the look and feel of it and how the colors and composition came together into a finished sculpture. With barely enough time to photograph the final piece, Metropolis was wrapped and shipped directly to VIA's booth at CEBIT. With good fortune, the display arrived safely and was set up at the entrance to the booth, where it received quite a bit of attention from the attendees and exhibitors.

Project Metropolis could not have been possible without the extremely generous help and support of some really fine people:

Michal Lisiecki of VIA Technologies, for his kind trust in my design and the enthusiasm he demonstrated in every step of the project.

Sascha from www.epiacenter.com, for getting the project off the ground and his commitment to the art and technology of case modding.

My brother Luciano, for his artistic talent, mechanical ingenuity, and big heart.

Johan "Mashie" Grundstrom, case modder extraordinaire, for his help and artistic vision.

My wife Jean, who has stood by me through many tough projects. Thanks for all the coffee, my love. CPU

by Paul Capello

Paul Capello is a professional modder; check out his work at www.thebestcasescenario.com.

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- Windows XP Pro

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256MB RAM 40GB HD
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MOD(ERN) ART

Enjoy Browsing This Collection Of Creative Mods

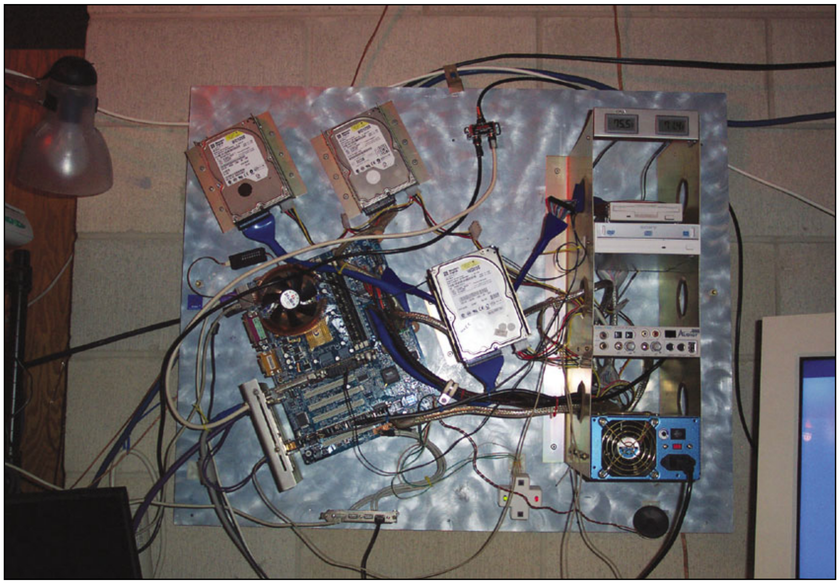
Wall Hanger

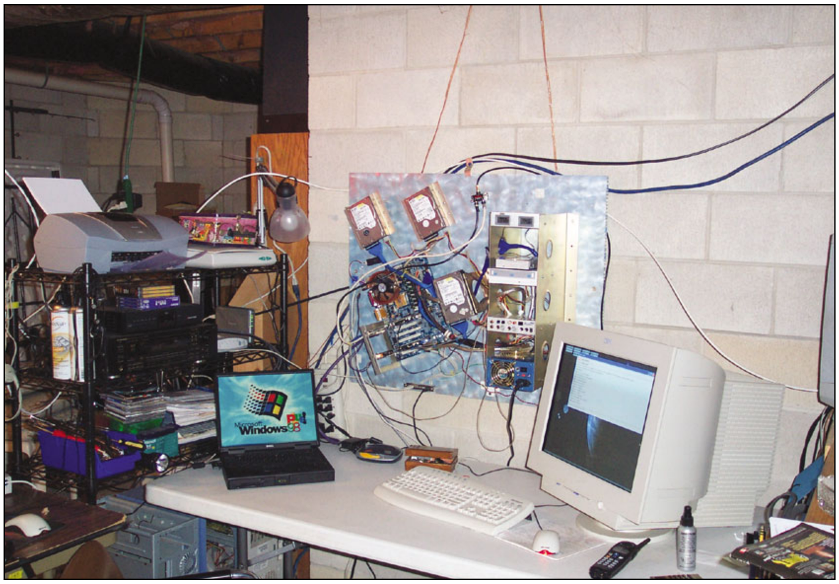
Mod by Mark Krivanich

The case on my computer was always open. I fix computers for friends and associates as a hobby and use my rig as a test bed for troubled components. One day I thought, "Why pack all of this stuff into a metal box? Wouldn't it be nice if it was all open and accessible?" So I built the wall hanger. I like to think of it as functional industrial art.

The "canvas" is aluminum honeycomb. This material is used to manufacture flight control surfaces for aircraft, so it's very light and very strong. All of the sheet metal was cut and formed from aircraft-grade aluminum. I am in the aerospace business, so I have access to these materials. Some may not consider this a case mod, as there is no case, but it is a "mod," and it works well for me.

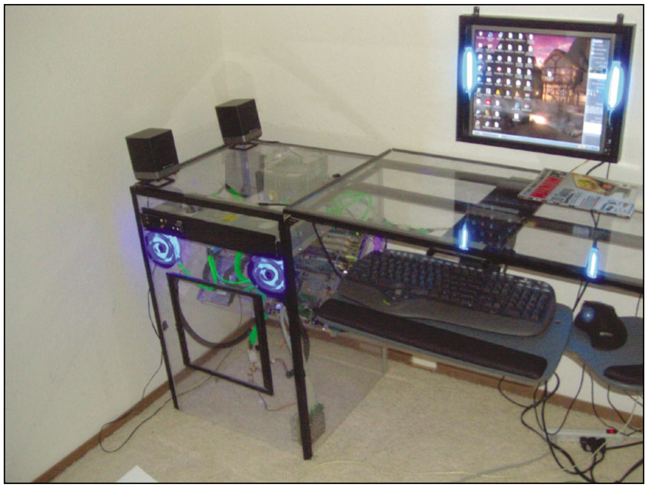
The Audigy sound card is pumped through a 400-watt Pioneer surround-sound amp and into two JBL studio monitors, two Bose 151s, and a Mirage subwoofer.

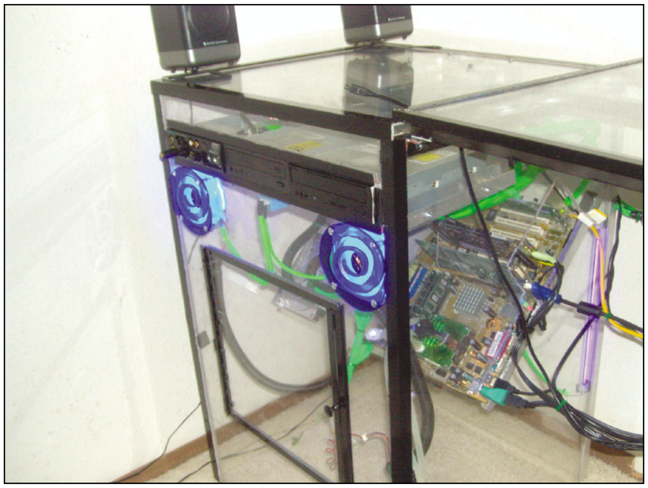




Tech Specs:

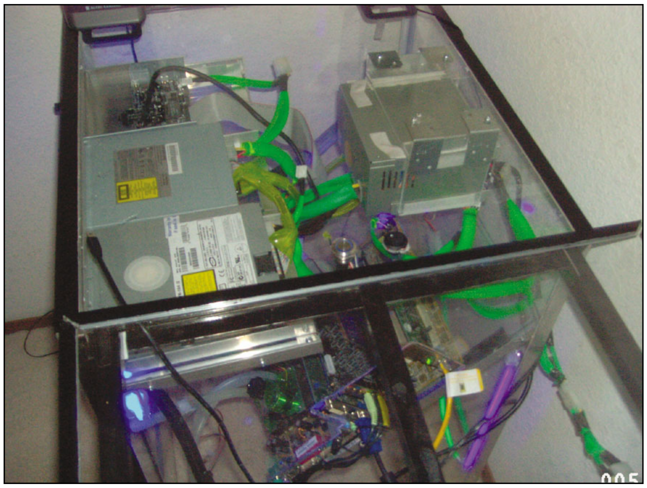
MOBO: Gigabyte GA-7VRXP
CPU: Athlon XP 2100
HEATSINK: Zalman 7000 copper
RAM: 1GB PNY PC2700
DISPLAY: 21-inch IBM P275 monitor
AUDIO: Audigy Platinum
HDD: Two Western Digital 1200JBs striped in RAID 0, one Western Digital 20 gig
CD/DVD: Sony DRU 530A DVD burner, Sony 52X CD burner





Plexiglass Heaven

Mod by Patrick Denney



I started this project back in February. I had always loved the idea of the clear cases, but it seemed a little too generic for me, and I wanted something original. I had drawn up a handful of rough sketches in a notebook and let my wife flip through them until she found one that she liked.

I bought six 4- x 4-foot sheets of Plexiglass to start off with. I cut out the six different pieces of the desk. I then bought a handful of aluminum edges to fit around the side. I thought the project was a bust because I couldn't find anything to hold the Plexiglass to the aluminum. I tried everything from bolts to glue, but the only thing that worked was heavy-duty foam tape. After I got the basic mold of the desk together, I cut out a piece for my motherboard.

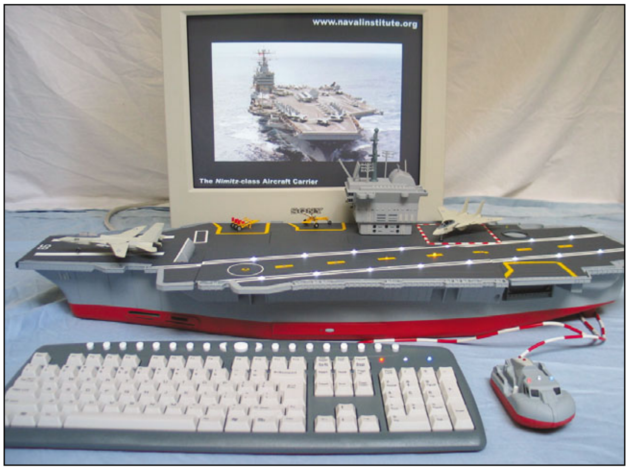
I used rubber pipe fittings to the hold the motherboard up and then I cut around the PCI cards. I installed a Silentstream watercooling kit to my board and ran the radiator and fan down to the bottom of the case for the best possible heat distribution.

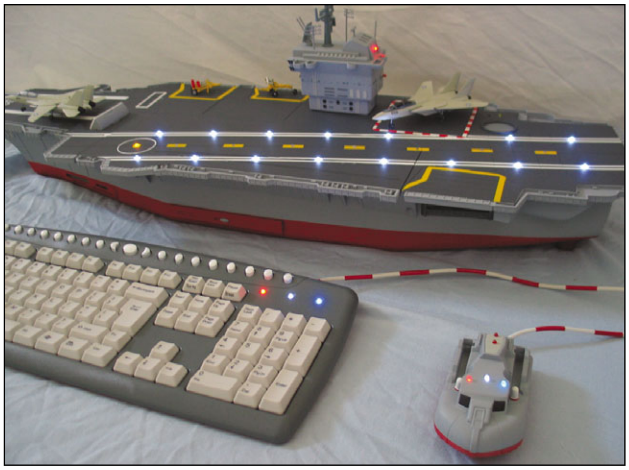
After I got the motherboard into place, I used two more small sheets bolted in from the side and the top to hold my DVD/CD drives in the front. I then bolted the power supply to the top of the case and added two 80mm fans with UV lights to the front for extra cooling. I cut out a door in the front of the case for easy access to my motherboard watercooling kit. I soldered in a blue power button on the top of the case along with a button that controls the two blacklights in the rear of the case and the two blue cold cathodes for my monitor. For my monitor, I butchered my old 17-inch LCD and filed down a 1.5-inch-thick display case I bought at a local art store. I fit the monitor inside and drilled out holes for the buttons at the bottom. I added two 6-inch blue cold cathodes on either side that are controlled by the switch on the top of the case. I then added green UV dye to my watercooling kit and wrapped the power supply in green UV wire loom and green UV sleeving.

Future plans for this project will include an in-dash LCD screen (like cars have) that will be hooked up to two satellite TVs and two security cameras outside. I am also working on plans for a built-in scanner and inkjet printer. This project took around 60 hours or more to complete. I'm a full-time student at NMSU and had to put in almost my entire weekends for six weeks to finish it.

Tech Specs:

CPU: AMD Athlon 2800+ (overclocked)
RAM: 1GB PC2700
GRAPHICS: ATI Radeon 9600
CD/DVD: Dual DVD/CD drives





Aircraft Carrier PC

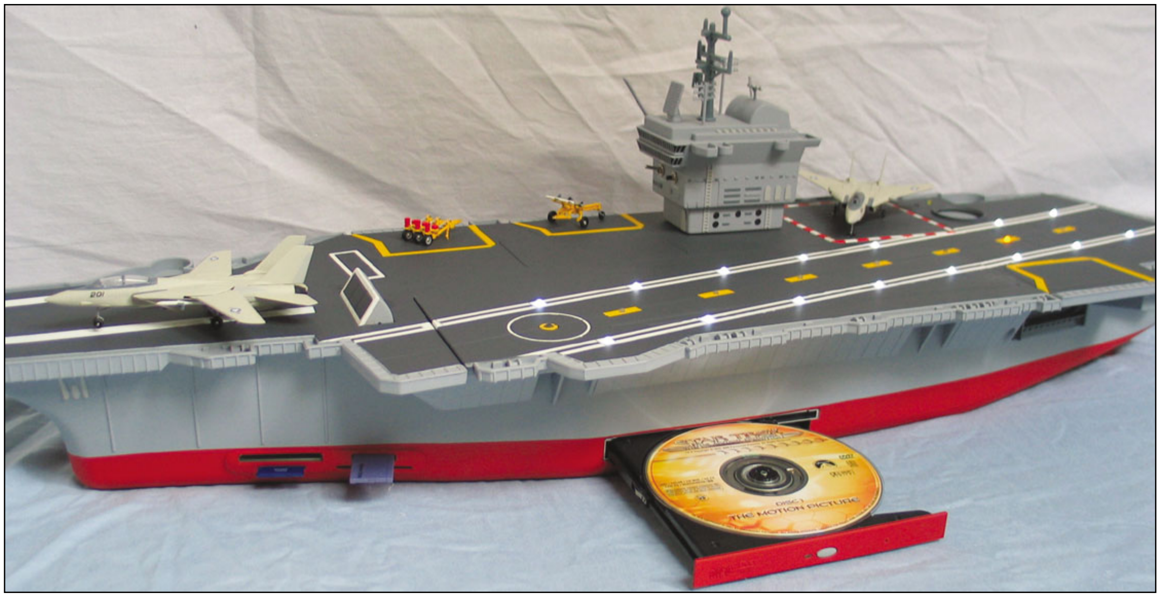
Mod by Russ Caslis

My latest creation is actually one of the US Navy's older creations but still a huge source of pride. Yes, this is one mod that doesn't miss the boat (pun intended).

The surface this mod simply looks like a toy ship, but peeling back the layers, there is much, much more. Yes, there is a computer inside based on a mini-ITX motherboard running at 1GHz. But there is also a DVD-ROM drive, FireWire and USB ports, 6-in-1 memory card reader/writer, 4GB hard drive, and a 10/100Mb Ethernet port. The mod also sports not only a custom paint job on the keyboard but a completely custom optical mouse. One of the F-14 fighter aircraft lights up as the hard drive activity light (blue cockpit, red engines), the runway lights up with a sequencing set of lights down the center, the F-14 hard drive activity fighter is removable so you can play with it, and the mod plays the national anthem on a built-in speaker!

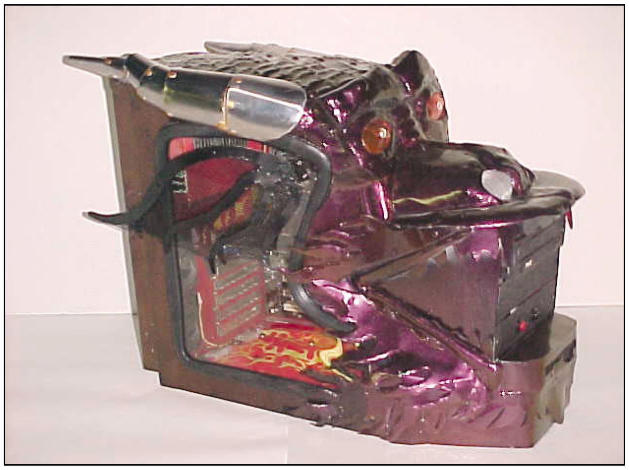
One day while walking through a toystore, I happened across a rather large, though simple, toy of the USS Enterprise aircraft carrier. After bringing the toy home, I realized that with careful planning I could fit both a mini-ITX motherboard and a DVD-ROM into the case. The entire toy was repainted and had electronics and lights added, the F-14s were built from simple model kits (including adding lights to one of them), and all the ports and openings for the computer bits were cut out. Then the computer stuff was added, as well.

It is true that this system is no game-playing system. But with all the features it does have, this system can't be beat as a movie-watching system in front of the TV. This mod would make a fine addition to any living room. Anyone up for a showing of "Top Gun"?



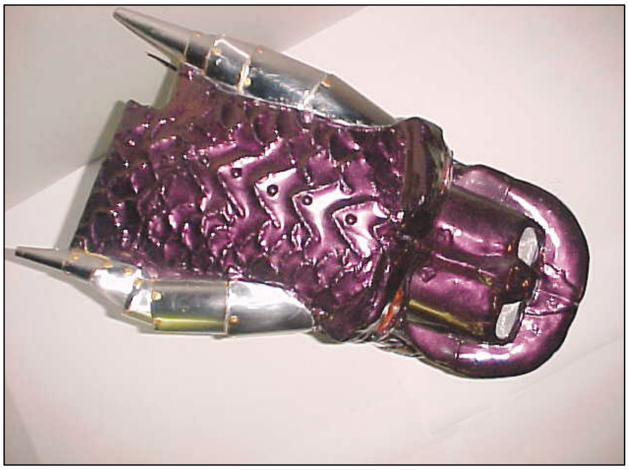
The Hard Drivin' Dragon

Mod by Charles Jackson, a.k.a. Duck



A donor case (believe it or not, this bad boy used to be a boring, old EN7101 beige box), some scrap metal, Plexiglass, cardboard, fabric, and a whole lot of hammering came together to produce Charles Jackson's unique Hard Drivin' Dragon case. Built from January to July 2003, the Hard Drivin' Dragon is currently in the process of upgrading the tech bits.

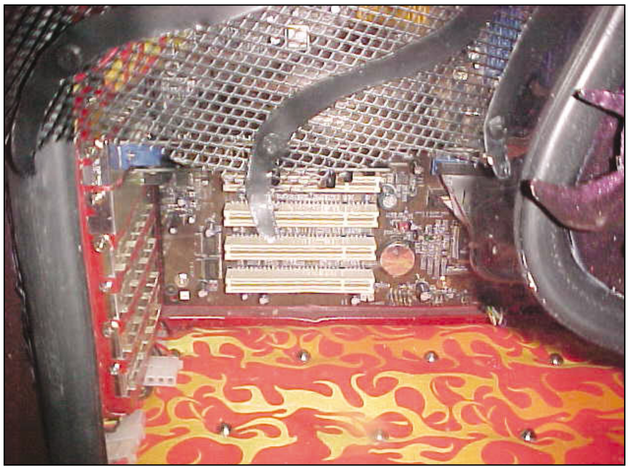
This one's no slouch in the light mod department, either: blue orb coolers on the CPU and chipset, blue Thermaltake heatspreaders, a red LED fan mounted on a stainless steel bracket behind the eyes (that draws in air through the nose), and a green LED fan in the rear. There's also a lot of chrome, particularly the fan grills and the mesh around the nose area. On the outside of the case, the Dragon is decorated with color-shifting paint that switches between maroon and gold. The inside sports red paint and red and yellow tribal flame upholstery.

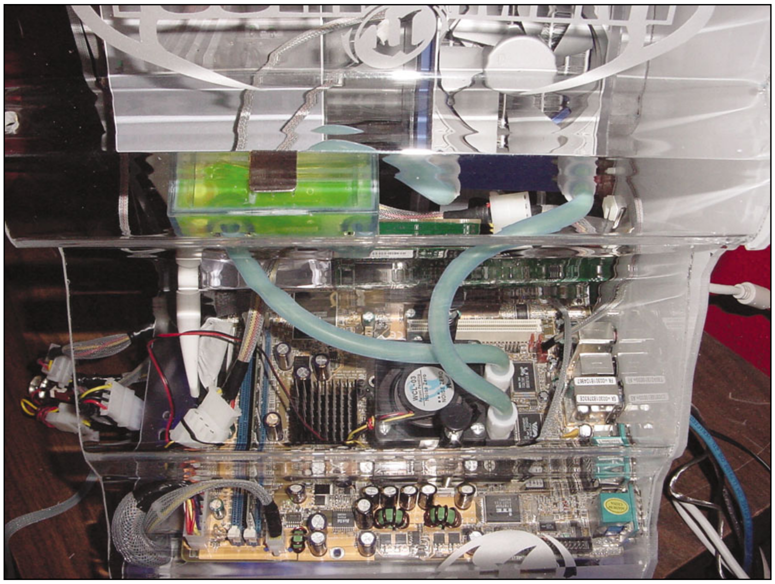


The Dragon was riveted together, but if he had it all to do over again, Charles would have gone the welding route instead. Overall, though, Charles counts this awesome mod as a "great learning experience," so we'll have to keep our eyes peeled for his future projects.

Tech Specs:

CPU: 500MHz AMD k6II
RAM: 256MB
HDD: 30GB
CD/DVD: HP CD-RW



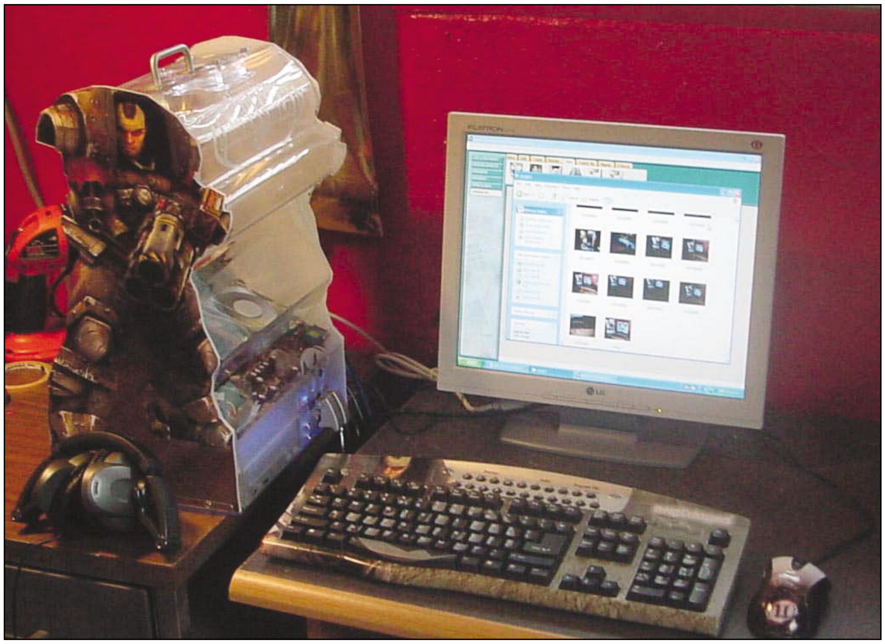


Tech Specs:

MOBO: Shuttle SK41G
CPU: Athlon XP 2200+
RAM: 512MB Crucial
DISPLAY: 17-inch LG LCD; 16ms response time
VIDEO: ATI Radeon 9200
HDD: 80GB
CD/DVD: Custom-cut clear acrylic Artec

The Unreal Case

Mod by Sheldon Bright



This is a custom case I built from scratch, gutting a Shuttle SK41G. The CPU is an XP2200+ Cooler that formerly had an SLK-800 with a Thermaltake Smartfan II painted silver (now it rocks a Poseidon watercooling kit). I used three blue LED strips I got from monsterlight.com around the bottom of the mobo and added a white hyper-light and two white LED fans. I stealthed the drive with a custom printed graphic from my shop. All the fan grills are custom-made, along with the vinyl etchings.

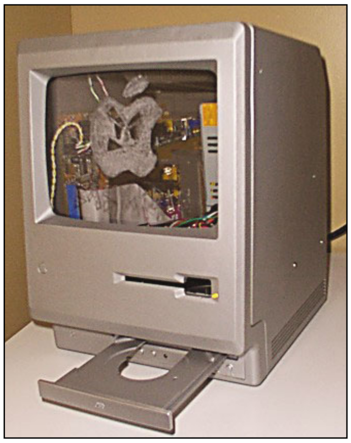
I had wanted to make a custom acrylic case for some time. I don't really like the square-shaped box and thought I should make mine curve around another shape entirely. I picked a character from the Unreal series because, at the time, the new 2004 version had just come out. I had been a fan of this series since the beginning, and the character had a good blocky shape that lent well to Plexiglass bending. Soon after building the case itself, I added fan holes and a whole lot of etched vinyl and edged graphics to both ends. I then decided I needed to skin my keyboard and mouse, as well, to match. Then I thought "What the heck?" and designed a mousepad in the shape of a the Unreal "U" from koolpcmods.com, which is the only mod I didn't do myself.

I wanted the UTMod to be something that had never been seen before. I am constantly trying to finish this mod, and it just keeps begging for more. Recently, the Shuttle PSU went out. It wasn't pumping enough power, so I had to mod an Antec 350w Smart Blue to fit into the spot the Shuttle PSU took up. Luckily I had a little headroom (see pics). I also added blue LED feet, a fan hole for the video card, and matching custom-made fan grilles for the back. The last thing I need to do for this mod to be complete is the 17-inch LG LCD; I'm going to build an acrylic case for it.

1660% Mac Plus Upgrade

Mod by Steven Lawver, a.k.a. Captian Slug

This is a gutted and reconfigured old Mac Plus 50 (which used to run at a heart-stopping 50MHz when it was new). Steven built this machine mainly on a dare, but it started to take on a life of its own. After refitting it with newer hardware, he etched the "Bad Apple" design on the screen (which now served as a case window). The tech specs won't exactly blow your gaming rig out of the water, but Steven says it was built as a budget PC.



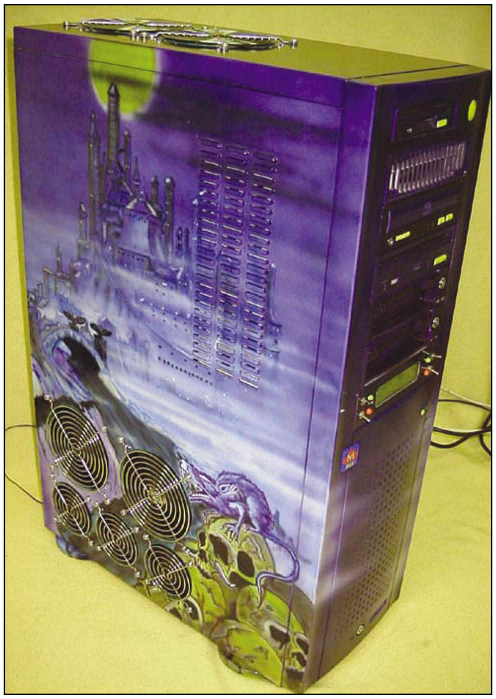
Tech Specs:

MOBO: FlexATX Socket370
CPU: Intel Celeron 566MHz
RAM: 384MB
HDD: 10GB
CD/DVD: "Naked" CD-ROM

Tower Of RagE

Mod by A. Dale McLean, a.k.a. PS-RagE

Fans of *CPU* may remember the 2002 Nissan Frontier that doubled as a rolling computer (Jan. 2004). The responsible party, known on the 'Net as PS-RagE, uses the monster pictured below as his primary machine. The mod itself is finished, but according to PS-RagE, the machine will never be, as he's constantly upgrading and fiddling with the insides. Below are the latest numbers for the Tower of RagE.



Tech Specs:

MOBO: ASUS P4C800-Deluxe
CPU: Pentium4 3GHz (800MHz FSB)
RAM: 1GB Corsair XMS
VIDEO: ASUS 9800 Pro (256M)
AUDIO: Creative Audigy 2 ZS
HDD: (2x) Western Digital Caviar 30G with Promise Fasttrac RAID Controller (RAID 0)

Projekt: The "O"

Mod by Bruno Ferretti

I started The "O" at the end of January for my little boy's birthday.

To start with, I had a boring, beige, no-name case. I used Plexiglass for the front and the top (and, of course, for the side windows) and mesh on the front and sides.

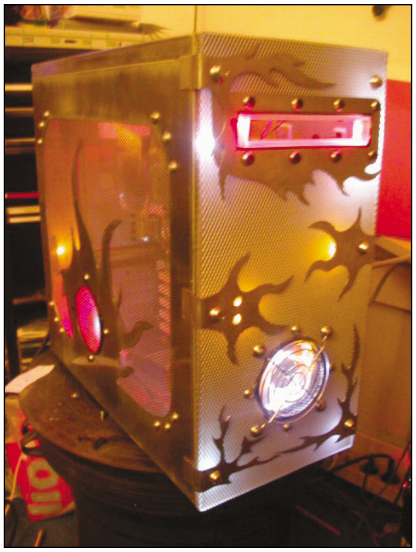
The cuts were all made with a Dremel, and the metal parts on the front were cut from an old case top to keep the 90-degree angle.

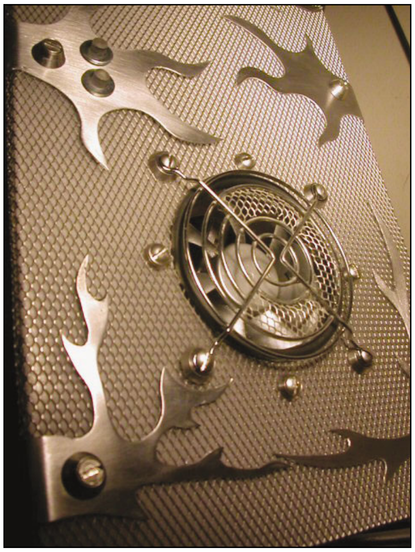
The three lighted fans are homemade, and I'm particularly proud of the side fan bezel with orange lights—I've never seen that anywhere else.

I think that the success of this case is due to the relatively simple way I've done things; the case's feet, for example, are aluminum, wood, and LEDs. Anyone can do feet like these for his case; it's easy with enough imagination.

Tech Specs:

MOBO: Gigabyte GA-7N400 Pro
CPU: AMD Barton 2500+
RAM: 512MB PC3200
GRAPHICS: HIS Excalibur 9600 Pro
HDD: Maxtor 80GB, 8MB cache, ATA/133



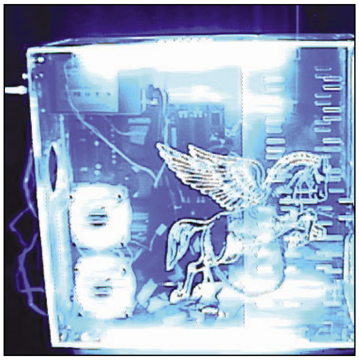


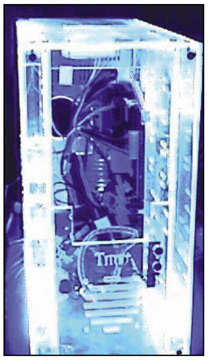
The Titan

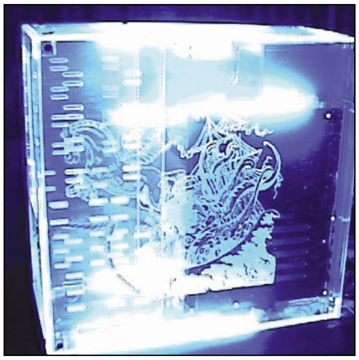
Mod by Michael A. Smith

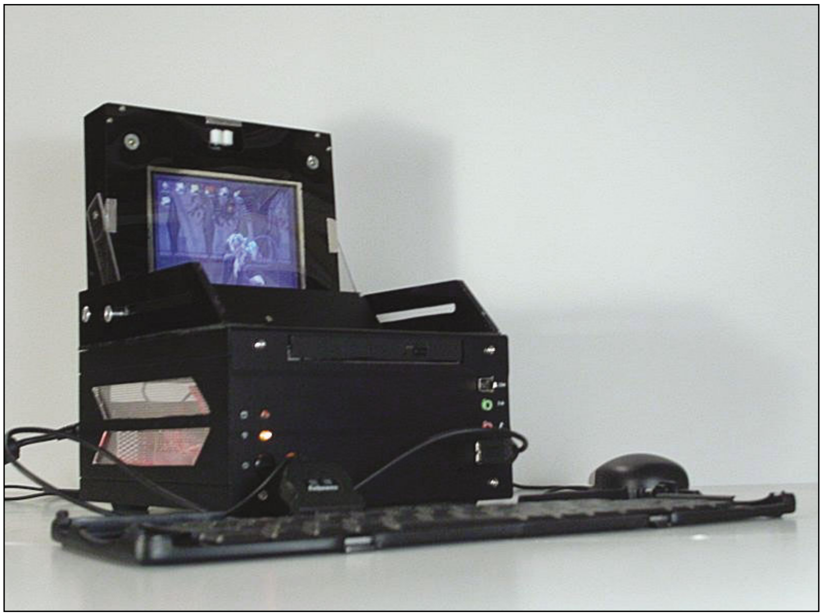
When Michael Smith of Infinity Custom Computers decided to build the complete ultimate computer, he, of course, knew he had to have a case worthy of it. The finished machine will contain some of the highest-level, state-of-the-art components available, including a P4 3.2GHz HT processor, 2GB of memory, 400GB of hard drive space, DVD±RW, CD-RW, temperature controls and readouts, UV and effects lighting, a lighted base, UV sleeving, UV cabling, and more. When finished, it will be a true beast of a machine.

All over the case are etchings of the ancient Greek legend of Perseus and Andromeda (who, themselves, are each etched on the front of the case; you may remember them from *Clash of The Titans*). The right side of the case features a highly detailed etching of the mythical Kraken reaching up from a raging sea to tear apart an impressive old ship; the left side pictures Pegasus, the winged horse. Zeus and Medusa are etched on the top of the case.









FlameCube

Mod by Steven Lawver, a.k.a. Captain Slug

With the FlameCube, I wanted the most power possible in the least amount of space, and this is what I've come up with. I've modified nearly everything in this case including cables rounded and routed obsessively, side and rear ventilation, window in DVD-ROM drive, replacement of all case LEDs, addition of 14 red LEDs to light the inside of the case, shortening of the CPU's heatsink (Dynatron DC1027B-X) to 1U level without affecting performance, direct power wiring of Video LCD, and custom machining of plastic LCD lid mechanism/enclosure.

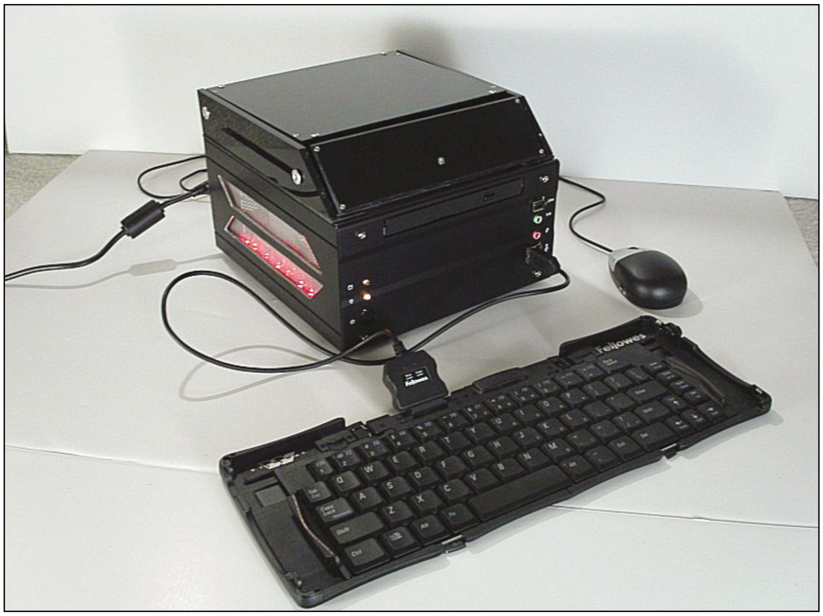
Dimensions: 8.5 inches high x 8 inches wide x 6 inches deep

Weight: 9 pounds

Total time spent modding: 40-plus hours.

Tech Specs:

MOBO: Intel 845GE chipset Commell LV-670LVDS
CPU: Pentium 4 2.4GHz
RAM: 512MB PC2700 DDR
DISPLAY: 5.6-inch Video LCD
HDD: 40GB laptop hard drive
CD/DVD: 8X laptop DVD-ROM drive



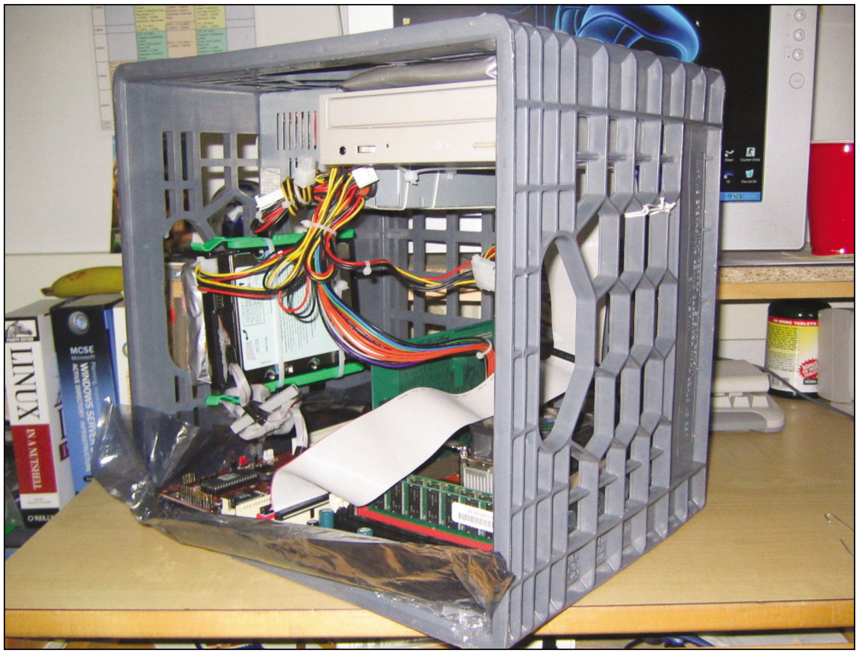
Elysium

Mod by Alessandro Palazzetti

I am a student at the University of Connecticut, and as we know, college is expensive . . . so I created a case that is based around a student's budget.

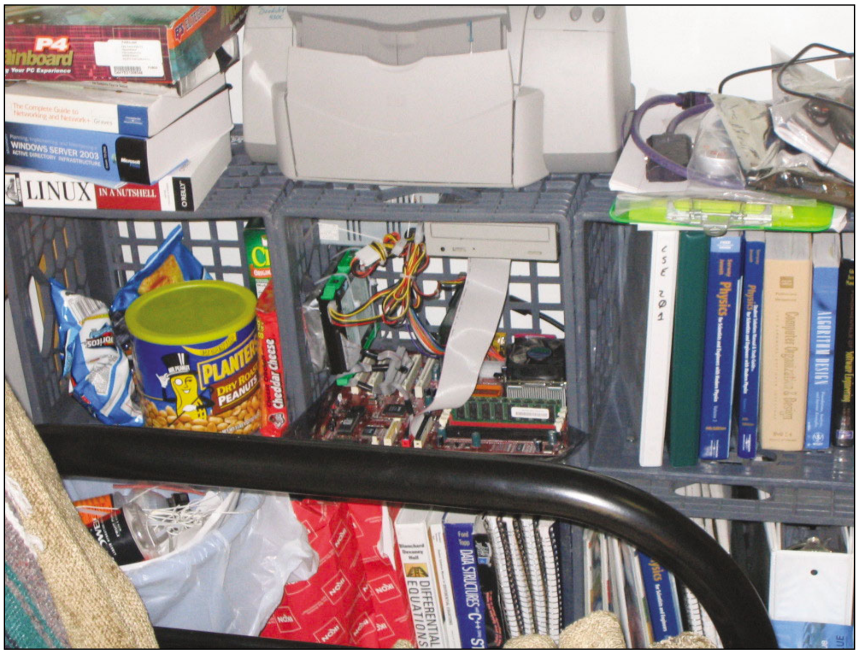
The case was created from a normal milk crate. I used zip ties to hold the hard drive and CD-ROM drive to the case, and to prevent from shock on these devices, I placed foam (the stuff that's usually found in a motherboard box) wrapped in duct tape (to dissipate heat quickly) between the peripherals and the crate. The PSU is hung by string. On the inner base of the crate, I placed bubble wrap and then placed a large anti-static bag (the one the motherboard comes in) for the motherboard to sit on. To build this I used a regular steak knife (to cut out the holes in the back), duct tape, and zip ties.

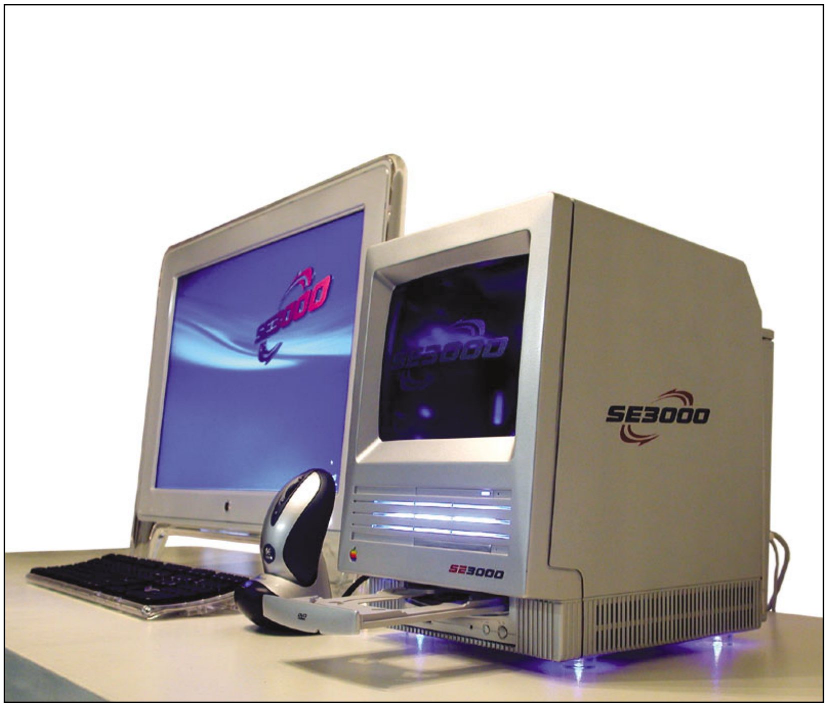
I am currently running SuSE Linux on it; it was a CounterStrike 1.6 server and Linux test machine. The reason I call it Elysium is that the Norse Gods had Valhalla, but the Romans had Elysium. The name was mostly based on the fact that it was a CounterStrike server, but it stuck for the mod name. Not exactly meant for the Gods, but for the fallen heroes, it was good enough.

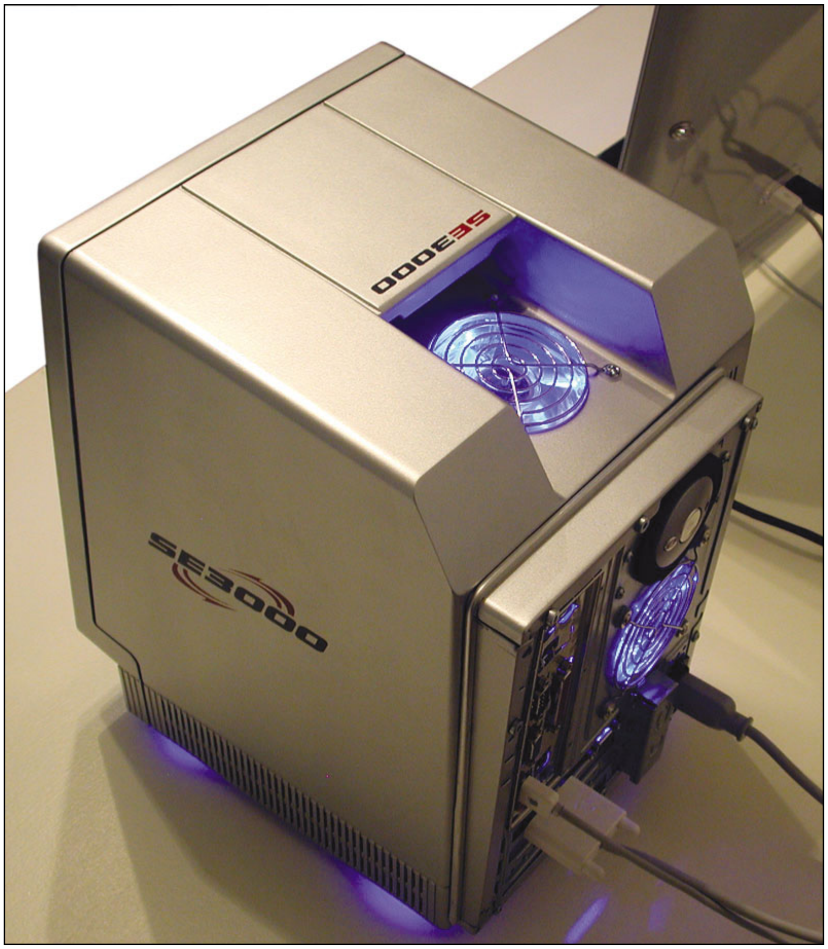


Tech Specs:

MOBO: Generic
CPU: Intel P4 2GHz 400MHz FSB
RAM: 712MB of Crucial PC2100
VIDEO: Voodoo Banshee







SE3000

Mod by Attila Juhas of AJ Design

Instead of building a milquetoast gaming rig, Attila Juhas decided to jump back in time and (sort of) resurrect the Mac SE. Armed with a Dremel, a Skilsaw, some spray paint, and a lot of patience, Attila gutted the old Mac and replaced its innards with cutting-edge gaming technology.

Particularly impressive is the new case window, which is the old monitor cut with sandblasting technology to show off the interior light mods.

Tech Specs:

MOBO: Gigabyte GA-8IG1000MK MicroATX (800 MHz bus)

CPU: Intel 3.0GHz Pentium 4 (800MHz front-side bus)

RAM: 1GB Corsair XMS Pro dual-channel DDR400 SDRAM

VIDEO: ATI Radeon 9700 PRO 128MB

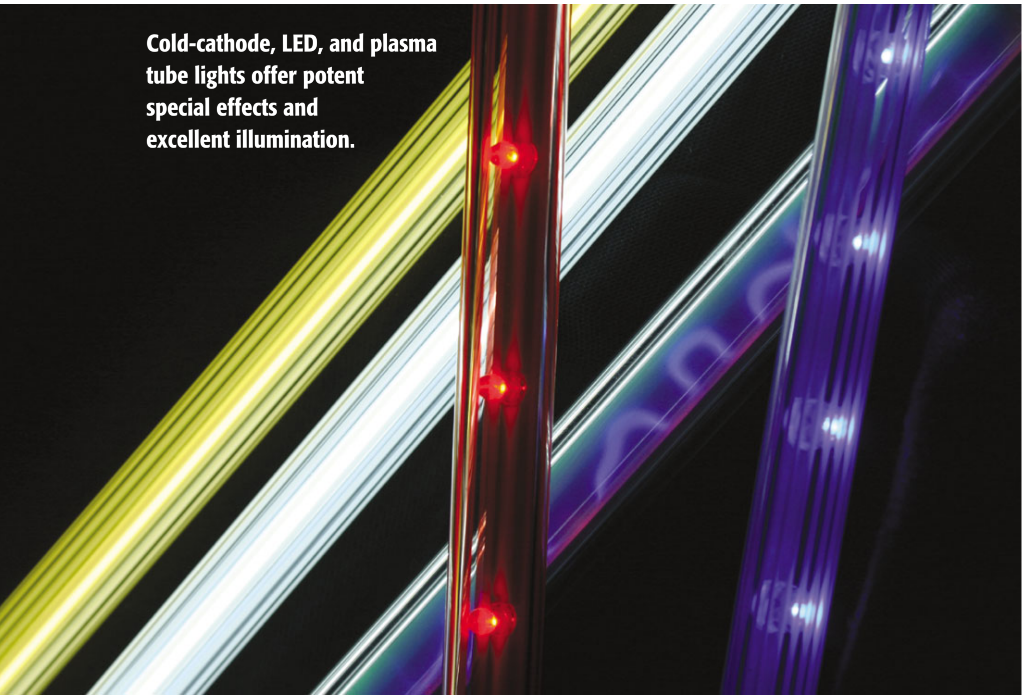
AUDIO: Integrated six-channel AC'97 Audio with universal audio jack

HDD: 120GB Seagate SATA 7,200rpm

CD/DVD: DVD/CD-RW combo drive

LIGHT MY FIRE

Illuminate Your Hot PC, Rave Style


Cold-cathode, LED, and plasma tube lights offer potent special effects and excellent illumination.

In the beginning, there were just plain old PCs. Beige PCs. Boring PCs. PCs that attracted nary a look of envy from your Half-Life opponents, nor lustful glances of passerby babes.

And then there were lights. Lights to push back slithery shadows. Lights to blind the eyes of anyone who dared challenge you to multiplayer Medal Of Honor. And indeed, lights to signal high hormone levels to potential mates.

So admit it, your PC needs a lighting makeover. Don't worry, we can help. Just come this way, towards the light.

Your Technological Options

Thanks to the exploding popularity of modding, you can have your pick of beams, rays, and strobes to make your PC shine with brilliant luminosity. Just be prepared to pick and choose because decorative PC lighting comes in myriad forms to help you illuminate every corner of your case.

In fact, there are so many lighting options that you'd have a hard time cramming the various products into your PC without coming off like a deranged hippie. But if you understand the different light technologies at your disposal and plan accordingly, you can create a pupil-penetrating presentation worthy of Times Square.

LEDs. Light-emitting diodes were among the first technologies to jazz up PC cases. They're bright, last practically forever, have low energy requirements, are nearly unbreakable, put off very little heat, offer directional illumination, and thanks to digital technology, LEDs often light up in a preprogrammed pattern.

LEDs are semiconductors, which means they have the ability to conduct varying levels of electricity. Manufacturers dope (chemically treat) the semiconductor with impurities that change the electron structure of the conductor material, adding either more negatively charged particles, or more space for electrons to move to (which in essence gives the material spare positively charged particles). Thus, diodes include a negatively charged segment and a positively charged segment. Apply an electrical current to the diode and the negative and positive sides interact, releasing extra energy in the form of photons and visible light.

Different diode materials produce varying photon energy levels. Because of this characteristic, manufacturers can create LEDs that produce different wavelengths of light, from the invisible infrared light generated by the LED in your DVD player's remote control to the green LED that acts as your hard drive's activity indicator.

In addition to old-school LEDs, you can buy laser-emitting diodes, which are a little different. While regular LEDs discharge light out the sides and tips of their transparent housing, laser-emitting diodes discharge light mostly through their flat, polished ends because their sides are roughened to trap and focus light. This trait means laser-emitting diodes shoot light in one direction, amplifying the light and creating a powerful beam that has all sorts of potential uses.

Blacklights. Blacklights are the disco balls of the new century—only this time around, no one's listening to K.C. & The Sunshine Band. These lights offer effects so weird they're practically mind-altering, but exactly how do they work?

In short, blacklights harness the light-reactive traits of chemicals called phosphors to produce striking visual appearances. Phosphors are substances that react to certain wavelengths of light by (you guessed it) giving off more light.

To get a wicked-looking blacklight effect you have to first create a blacklight. Regular fluorescent lamps contain a phosphor coating that produces a whitish glow. Blacklight fluorescent lamps have a different coating that filters most light wavelengths, producing only UV-A (an ultraviolet light that's less harmful than other UV wavelengths) and purplish light. Incandescent blacklights are just regular household bulbs with filters that emit only UV-A and a violet glow.

Fluorescent and incandescent blacklights produce their glow differently, but the end result is the same—that is, the light waves interact with phosphors located in the room around the blacklight, causing those phosphors to put off a glow that's visible to the human eye. Phosphors are practically everywhere, which is why teeth, fingernails, and even laundry detergent glow when subjected to a blacklight. Indeed, the phosphors in detergent are the reason white clothes glow so brightly in blacklight.

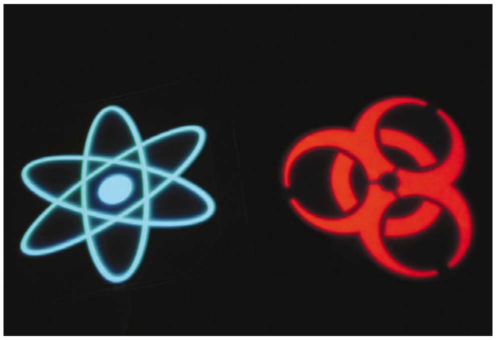
But why do phosphors glow? Basically, UV-A light excites the electrons in a phosphor's atoms, causing those electrons to move to a higher energy state. Blacklights typically excite those electrons for only a brief period, which is why your UV-reactive Black Sabbath poster stops glowing once you turn off the blacklight. Other phosphors, such as those found in glow-in-the-dark toys, maintain their glow for minutes or hours in complete darkness. Most of the phosphors found in modding products react to blacklight but can't sustain a glow without a light source, a fact to keep in mind as you plan your lighting system.

EL tech. One of the newest lighting mod technologies comes in the form of EL (electroluminescent) wire or strips. EL wire puts off a neon-like glow, but without many of the problems associated with traditional neon technology. Where breakable neon comes in hardened shapes and tends to burn out in sections, EL wire is very thin (about a third of the diameter of a number two pencil), flexible, cool to the touch, requires very little power, and has no hot spots like those inherent to LEDs or filament bulbs.

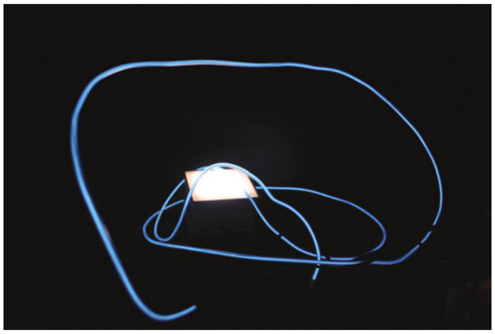
EL wire harnesses phosphor characteristics to produce its intense glow. These lights have a central copper wire with an organic phosphorous coating and two transmitter wires that provide an electrical current across the phosphors. A PVC layer protects the whole setup, with a colored vinyl layer to top things off. The wire glows for thousands of hours and never really burns out, though the glow will dim with age.

Most of the phosphors used in EL technology produce pink or white light. By changing the color of the top vinyl layer, though, manufacturers produce wire that appears blue, red, yellow, or any number of other colors.

The properties of EL wire make this product ideal for PC modding projects. You can worm the wire into tight spots with little fear of harming it, you don't have to worry about heat-buildup problems, and the diversity of colors means you can employ the lights with any wacky color schemes your devious little mind can imagine.



Space-age case badges plug into your power system and provide a super-bright glow.



Hyperlights are basically cold-cathode tube lights in a small box, helping you save space and still light up a large area. EL cables twist every which way and provide cool highlight effects.

Cold cathode. Cold-cathode lamp technology has been around for more than seven decades. These lamps work much like neon lights, meaning they have a hollow tube filled with a gas that glows when it meets an electrical charge, but where neon technology isn't feasible for PC modding, cold-cathode tubes are excellent for PC illumination purposes.

Cold-cathode lamps are similar to fluorescent lights in that they have components that produce electrons to support gas discharge, and as a result, light. But while typical fluorescent lights have coils that produce high levels of internal heat (about 900 degrees Celsius), cold-cathode tubes have a small component that operates as a relatively cool 200 C, hence the "cold" descriptor. Cold cathodes last much longer than regular fluorescent technology—at least 20,000 hours—and PC-ready versions have an acrylic or polycarbonate exterior that helps protect the thin glass bulbs from shock and vibration.

Cold-cathode lamps for modding usually measure either 4 inches or 12 inches and come in a dazzling array of colors, from red and blue to super-bright yellow and white. Because the lights have a clear coating all the way around their exterior, they illuminate in all directions, and many come complete with sound sensors that cause the lamp to flash in response to any sounds emanating from your PC.

Put It Together

Now that you have an idea of the lighting technologies available for PC modding, it's time to get a better idea of the effects you can expect from these products. We'll also give you modding ideas and show you how we put a few of our favorite gadgets to work for us. We'd be remiss to not mention the sites where we found the following products, so we offer our thanks to FrozenCPU (www.frozencpu.com), Xoxide (www.xoxide.com), Newegg (Newegg.com), and TigerDirect (www.tigerdirect.com) for their prompt service and excellent product selection.

Fans. PC enthusiasts install superpowerful or super-quiet fans, cut blowholes so they can install extra fans, and generally go out of their way to make sure these components work optimally. It's no wonder, then, that fans are a focal point of sorts of modding projects. Many fans are made specifically to cater to the needs of modders who want impressive visual effects.

Mind-blowing fans won't necessarily blow your budget. You can buy case fans that react to blacklights for only $5. These fans often glow blue, but there are other colors available, such as orange and red. The fan frames provide a strong glow, and often the blades glow, too, meaning there are dozens of potential color combinations to suit your needs.

Many of the glowing fans you can buy seem to be generic brands, at least on the Web sites that sell them, a fact that makes it hard for us to recommend specific makes and models. One exception is the AeroCool Chameleon LED fan, which includes LEDs that start out as blue and change to a pink hue as temperatures change. We also like Vantec's Spectrum UV LED fans, which have UV-reactive blades and frames, and thanks to built-in UV LEDs, you don't need an external blacklight to make them glow. These two fans cost a little more, at around $13, but they're definitely worthwhile.

You can pick up fans with four internally mounted LEDs for about $10. If you prefer cold-cathode effects on your wind makers, you'll spend $10 to $12 for each. If off-the-wall fans aren't enough, splurge on fan grills or adapters with UV-reactive properties or built-in LEDs.

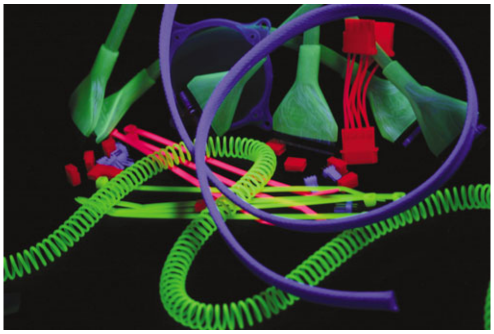
Cables and wiring. Cables and wires are a necessary evil for all PC users, but they're doubly troublesome for modders who have to find a way to make their tangled nest of wires look cool to LAN party bystanders. Happily, there are a number of glow products that make this task more enjoyable.

You can start by replacing your old-fashioned flat IDE and floppy drive cables with something a little more modern. We recommend rounded cables that glow under a blacklight. These cables not only cut down on airflow resistance (a big plus for those of you still using a forced-air cooling system), but they also come in orange, green, blue, and other hues that make color coordination a snap. These cables sell for less than $10.

In addition to data cables, you can replace many of the components that make up your power system. Try replacing your power wires and connector plugs with parts that react to blacklight. Don't forget about your fan wiring, because you can even go so far as to replace the male and female connectors for your fans so that even these parts will glow. These mods won't cost you more than a couple of dollars.

Of course, even after you replace your drab cables with new ones, you still have to deal with the problem of tidiness, or lack thereof. That brings into play a large number of organization products that will spice up your lighting aesthetics. Buy green or pink plastic zip ties that glow under a blacklight, and look for cable sleeves that radiate a soft blue or green glow. Again, these are cheap mods. Ties cost just pennies and cables sleeves are about a buck.

Fans come with built-in LEDs, blacklight reactive blades, or even color schemes that change as your PC's temperatures rise.



From cables to cable ties to blacklight-reactive fan plugs, there are enough lighting mods available to keep you redecorating for months.

Cold cathode and EL. Cold-cathode lamps come in a wide variety of colors, and we bought a yellow, white, blue, and red lamp for review. All of our test lamps were of the 12-inch variety, perfect for extra illumination. We mounted these lamps with the included Velcro pads, but we suggest using clips or even glue if you want the lamps to stay in place—tiny Velcro strips don't withstand much jostling.

Cold cathodes are plenty bright, but if you buy reflective tape, you can better direct the lamp's glow, and as a result, also make the light appear more intense. Single lamps don't really add a sense of completeness to most modded boxes, one reason most retail sites offer secondary lamps that you can add to your first lamp, a fact that also cuts down on wiring clutter and makes efficient use of a single inverter.

A single 12-inch cold-cathode lamp costs about $16, and you can buy a secondary lamp for half the price. In addition to picking your favorite single-color lamps, we highly recommend so-called liquid neon or plasma lamps. These lamps resemble plasma balls, with lights that flow and flicker and react to the touch of your hand. They sell for less than 20 bucks. Some sites list Meteor Lights in their cold-cathode section. These aren't fluorescent lights—they're LED-based products that flicker, and even come with an adjustable speed control. These are fun, too, and sell for about $15.

Although the aforementioned tube lights are rigid and don't always stay put, EL wire is easy to push into tight corners, so long as you don't strain the wire to the point of damaging it. EL wire isn't as bright as a cold-cathode lamp, though, meaning it's best for accentuating edges.

Use strong, clear tape, or even silicone sealant, to secure EL wire. If you don't want to mess with EL wire, you can opt for an EL light strip, which is flattened EL wire with an adhesive backing. EL wire sells for about $20 for a 5-foot segment, so if you decide to go crazy with EL wire, it will cost you. Light strips cost more, with a 5 footer costing around $30.

If strips, wires, and tube lights don't excite you, or you don't want to spend so much money, you might choose $16 Hyperlights, which are basically a cold-cathode lamp crammed into a small box. These provide a great deal of illumination without the hassle and space consumption of elongated lighting products.

Badges and stickers. Stickers are a simple but effective way to add personalized touches to your case. These so-called "appliques" help set off case windows, and because they respond to blacklights, you'll not miss them in the dark. On the down side, these stickers are expensive, at about $10, but they are often oversized, so you don't need more than one or two to get your point across.

You can get a punchier effect from self-illuminated badges. They plug into your PC's power system and put off a potent glow. You can obtain your own badges in dozens of patterns and colors, and they typically cost anywhere from $12 to $20. If you don't like premade badges, you can buy a $15 kit and make your own.

Cooling fluids. You can't use straight tap water in a watercooling system. Doing so will cause quick corrosion of your various watercooling components, from the waterblock to your radiator, and may also encourage algae growth. Fortunately, you can use anti-algae, antirust coolant in your system. Better yet, many of these coolants contain phosphors that react to a blacklight. You can find red, blue, green, and other colors to make your watercooling tubes glow brightly, and these coolants cost less than $10 per bottle.

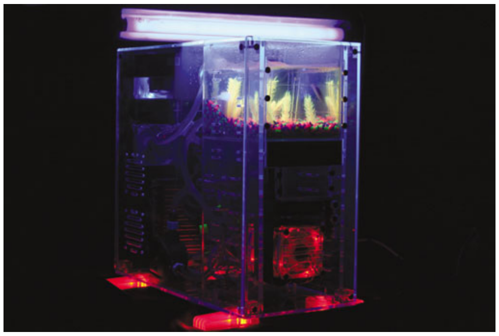
Paint. In spite of your many glow-product options, there may be other components you wish would respond to blacklight. Thanks to Clear Neon spray paint, you can paint just about anything, let the paint dry, and then flip on your blacklight and watch the object glow. Best of all, the paint isn't visible in regular light.

Clear Neon paint comes in eight colors including yellow, orange, and blue. If you apply the paint to, say, your PC case, and you decide you don't like the results, you can use soap and water to remove it. A coat of clear lacquer will make your paint job permanent.

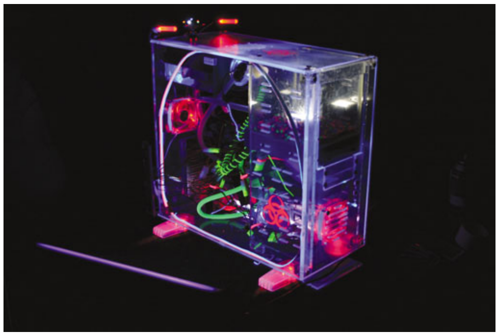
Needless to say, Clear Neon was one of our favorite lighting mods because you can use it for so many different purposes. The paint's glow is adequate under a blacklight, and you can strengthen or weaken the intensity by using more or less paint. Each can of Clear Neon sells for about $13.

Our Light Mod

After blowing hundreds of dollars on light-related modding equipment, we figured we should probably put at least some of our accumulated hoard to good use. To that end, we bought a $70 acrylic PC case from Extreme PC Gear (www.xpcgear.com). It's a clear case, so even though it required us to assemble it, this case's transparent sides helped us show off a mind-boggling (if somewhat tacky) light-modded PC.



Our fish tank included UV-reactive gravel, glow plants, but sadly, no GloFish . . . yet.



Sure, it looks like the Teletubbies puked all over our P4 after a wild night of partying. But imagine the possibilities if you have better interior decorating skills than us.

But first things first. We decided to put aside our toy collection for a few hours so that we could build a Plexiglas aquarium to put in our case's drive bay. Why would we do such a thing? Well, if you're going to have a big reservoir as part of a watercooling system, you might as well throw a few fish in the water for good measure. Our initial inspiration for this project was to integrate GloFish (www.glofish.com) as part of our light mod theme, but none of our local pet stores carried the little guys—and shame on the store that tried to pawn off lame, knock-off GloFish as the real thing. "No, those GloFish don't really glow under a blacklight. They look best under a regular fluorescent light." Right, thanks guys.

So although we didn't nab any GloFish, we did complete our project. We won't offer a lot of specific instructions so you can run out and copy our masterpiece PC aquarium, but suffice it to say this task was relatively simple. Pick up some Plexiglas and aquarium-safe silicone sealant, take careful measurements of the inside of your case, and you can easily build a reservoir-aquarium of your own. Just be sure to choose fish that will tolerate heat from your overclocking activities. And of course, we picked aquarium "components" worthy of a wicked PC mod. We dumped in a load of UV-reactive gravel, slipped in a couple of glow plants, and released the hounds, er, neon Tetras.

In addition to the slimier aspects of our light mod, we installed a range of other lights and LEDs to make our clear case shimmer and sparkle like a minnow's wet back. Be sure to check out the overall look of our system in the accompanying photos. As you do, remember if you want to install many similar products, you'll have to consider power requirements. It doesn't take many lights to stress a PSU, especially if your PSU is already busy with other power-hungry components.

Lights Out

Our roundup of light products is hardly the end all on this glittering subject. There are too many niche products to mention, and the possibilities even for one small LED are virtually limitless.

So use your imagination to take your light mods to the extreme, but don't keep your finalized project to yourself. Share photos and stories of your system on the CPU magazine reader forums. Because where there is light, there is love, or at least a chance to show off. CPU

by Nathan Chandler

THE PAINT BOOTH

Tips & Tricks For Cutting, Sanding & Painting

I have been modding for a long time, and sometimes I wish there was a magazine like this back in the day that I could have learned a thing or two from. But there was not, and I had to learn from my mistakes. It is from this experience that I can tell you some of the tips and tricks that I have learned along the way, so you don't have to go through the kind of frustration that I did. Modding not only requires the ability to build a computer, it also requires you to be a jack-of-all-trades—a good modder uses the same skills that craftsmen use, as well as using many of the same skills that electricians and system techs rely on. Therefore, you should be knowledgeable about the most commonly used techniques used in mods.

When working with cases, you run the gamut of materials that are commonly used: aluminum, steel, polycarbonate, acrylic, and fiberglass. Ironically, two or three power tools will cut all of these materials if you use them right.

The Right Tools

One of the must-have tools is the highly versatile rotary tool. Its multitude of applications and attachments make it an indispensable part of your arsenal. When picking a rotary tool, you want to look at quality of construction, torque, and RPM speed. For my money, the two forerunners in the market are the Dremel Variable-Speed MultiPro and the Black & Decker RTX.

Both offer variable speed selection, excellent torque, and the quality of construction is first class. Better yet, the tooling for both of these units is interchangeable, so you aren't left out in the cold when you need a specific attachment for the task at hand. I do not recommend cordless units because they typically lack in torque, and there is nothing more annoying than running out of juice halfway through a cut. Although the tools are very versatile, they are not good for cutting plastics because the high RPM rates melt the plastic rather than cutting it.

The Dremel Variable-Speed MultiPro, with its interchangable tools and high torque, is a modder's best friend.

Jigsaws can cut through plastics and aluminum like they're not even there, so it's a good idea to keep one around.

The Black & Decker RTX is a great choice for fine detail work and has interchangable bits so you always get the right cut.

Both of these tools are easy to find, however. The Dremel Variable-Speed MultiPro Superkit, which comes with every bit you'll concievably need, runs about $75. The Black & Decker RTX can be found online for under $60 if you're willing to do some searching.

A jigsaw is also an indispensable part of the modder's toolkit; its ability to work through just about every material with ease makes it my personal choice for large cuts. It can struggle with some metals, but it cuts through plastics and aluminum like butter, and you cannot beat the control you get with this tool. By using a jig, or just a steady hand, you can get nice straight lines and excellent curves on flat surfaces like a door panel.

Jigsaws are also reasonably priced, which makes it a great investment for any modder. A specialized acrylic cutting blade for your jigsaw is also a good investment and it can save you some headaches.

Jigsaws are usually pretty easy to track down at any neighborhood hardware store—the one we have pictured at left is a Makita 5.5 A, Top Handle Orbital Variable Speed Jigsaw. You can usually get one for around $150, though prices may be a bit better at shops on the Internet.

Finally, a good drill is worth the price. I use a cordless drill for quick hole drilling and the corded drill for hole saw cuts and difficult drilling. The extra torque and power really help out when you have to muscle through a thick piece of steel.

Preparation Is Key

No matter what tool you are using, it is important to take your time and prepare for the task at hand. Take it from me, there is nothing more annoying that screwing up a cut and having to start over from scratch.

Before I even pick up a tool, I make sure to mask off the areas I don't want marked or scuffed, make sure I have all measurements correct, and I have marked my cutting area appropriately. Preparation is the key to keeping accidents and unexpected complications to a minimum, especially when it comes to cutting materials. Besides, taking a little time to prepare in the beginning will save a lot of time fixing mistakes later.

Files and sandpaper are also indispensable to the kit; these are the tools that make you look good. You can easily fix a less-than-perfect cut or jagged edge with a file.

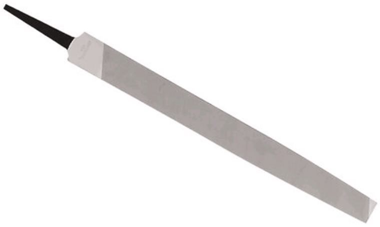
I always keep a good selection of different sandpaper grits and types in my toolbox, as well as assorted hand files of different sizes. I have a steady hand, but every once in awhile I really screw up a cut, and I am glad I have a file and some sandpaper within reach.

Paint Types

One of the most common questions I am asked is "What kind of paint do you use?" This is not an easy question to answer because I use many different types of paint; it really depends on the project. I prefer to use automotive paint when I can, but I do not have a paint booth so sometimes I have to make do with spray paint.

Dupli-Color enamel is one of my favorites because of its quick drying time and its large selection of colors. It is available at most auto parts stores, so it is not hard to find in a hurry.

Getting a high-gloss, show-car finish with spray paint can be a chore, but the elbow grease it takes is well worth it. I prefer to start with a clean surface when painting, so I use a chemical stripper to get a prepainted case down to bare metal. I then clean the surface and prepare it with some denatured alcohol (which you can find almost anywhere, even at the grocery store)—this way there are no oils or greases to inhibit the primer from adhering to the surface.



Always keep a wide selection of files handy—when you get a little jigsaw-happy and ruin a cut, you'll be glad you have them.

Prime Away

First, I put on two coats of primer in a nice even layer. I then lightly wet sand the case with some distilled water. This smoothes out any rough spots in the primer. The primer coat is only a few microns thick; if you sand too hard and expose the bare surface you will have to start over, so be sure to take your time.

I am now ready to paint, but paint does not go on smooth. If you look at paint under magnification you will see it has a pebbled texture, so color sanding is needed to give each coat a smooth finish. With a little distilled water and 2000-grit sandpaper, I color sand each coat and then wash it clean with some alcohol and a soft, cotton cloth.

After three coats of paint, I like to let the finish cure for a day or so, and then it's time to polish the paint. I don't have a preference in wax or polish; I just head out to the auto parts place and pick what ever catches my eye; to me they all work similarly.

I like to start by very lightly color sanding and cleaning the part; I then polish the part by hand and give it a second coat with a buffer or a drill with a buffing pad attachment. The object is to not have any swirl marks or imperfections in the paint, so always take some time to get it right—it's well worth it to see that deep gloss come through.

Dupli-Color enamel is inexpensive, comes in a large selection of colors, and is easy to track down at most auto parts stores.

Working With Plastics

Plastic is a completely different animal when it comes to painting. Unfortunately, most cases are made with a textured ABS plastic bezel, so it is a necessary evil. Whenever possible, I use vinyl dye because it penetrates the surface rather than coating it like paint.

When I have to use paint, though, I sand the bezel smooth with some 1000-grit paper and then prime and paint like I normally do. But I only polish plastic by hand; it is far too easy to ruin plastic parts when using a buffing wheel.

Regardless of the material you are cutting or painting, it is best to take the time to mask and measure. When I first started modding, I thought that it would be quicker to rush through the preparation phase, but in the long run I was spending more time going back and fixing mistakes or repainting parts than I would have if I had taken the time to do it right the first time.

Measuring your cuts and masking off surfaces correctly will save you time and energy, making your experience more enjoyable—and that is why we mod stuff in the first place.

Building your own case and making it one of a kind is the goal, but the payoff is knowing that I put in the effort to create something that is an expression of myself and learned something in the process. CPU

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by Gareth Powell

Gareth Powell ("Lord Pheaton") is an accomplished modder and runs pheaton.com, which hosts reviews, tutorials, and the infamous Pheaton Forums.

REMOTE CONTROL WIZARDRY

Install & Modify Your Transmitter/Receiver Combo

Someday in the not-too-distant future, you'll awaken late on a Saturday morning, roll over in bed, and imagine your PC powering up and launching Half-Life 4—and, thanks to that tiny microchip implanted just behind your ear, it will do your bidding and actually launch. You won't even have to get out of bed to start offing baddies because your VR-enabled glasses will let you sprawl across your pillows while the electronic blood splatters.

OK, let's say those "user-mods" are a little too extreme for your tastes, but you still want to have some remote control capabilities over your PC. With the following modifications, you will be able to reset your PC, turn it on or off, play games with your CD-ROM drive, and for fun, cause serious distress to your friends when they can't figure out why your computer appears to be possessed.

More Than Cool

Modern PCs aren't really wired, physically or logically, to be used with remote controls. Your computer is a hands-on device that needs significant user input via keyboard, mouse, or other device, before it knows what kind of data to process. There are a few exceptions, of course, such as multimedia PCs designed for music playback, but these setups aren't the norm.

There are precious few remote control products for modders who want just a sliver of PC remote control capability without spending a lot of money or time on their systems. To that end, we present the Just Cooler remote control kit, which is available from your favorite modding site. This kit doesn't require any soldering or painstaking wiring, as it includes just a receiver, transmitter, and antenna.

The receiver is smaller than a video card and has a petite, rectangular circuit board and a rear-mounted jack for the antenna. The transmitter looks like your car's door lock remote, but with differently labeled buttons—but if your car came with Power and Reset buttons, please email us and tell us about it.

Insults & Instructions

Installing the Just Cooler remote control system is straightforward, but the company neglected to include even basic instructions. All you receive are two poorly translated and punctuation-challenged sentences of supposed specifications: "A keychain controller device specially design to operate the computer POWER by way of transporting signal on ATX motherboard from up to 20 meters. It serves as a friendly user to those who couldn't get the hang of pushing the POWER/RESET buttons of their PC." As a result of this product shortcoming, we'll walk you through the installation process.

You can start by picking a suitable expansion slot for securing the receiver. You don't need an empty PCI card slot because nothing connects to the motherboard, but you do need a little room for the bulky receiver components, and you should pick a slot close to your motherboard's power and reset connectors so you won't strain the rather short wires that come with the kit. Don't secure the receiver with a screw just yet, as leaving it out of the case makes it easier to connect the required wiring.

Now you can pull the reset and power button wires from their motherboard connectors, and then tie these wires up and away so that they don't end up tangled in one of your case fans. After making sure they are properly oriented, connect the kit's power and reset wires to the motherboard, and connect the other ends to the receiver. As they are on the motherboard, the appropriate connectors are labeled, which simplifies this task.

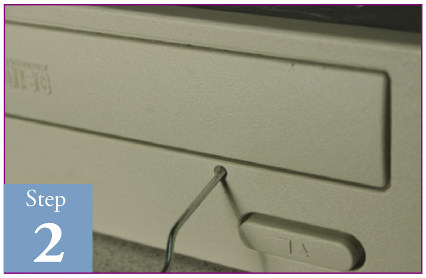
Disconnect the ATX power plug that connects the PSU to the motherboard. Now take the ATX PSU pass-through connector that came with the kit and plug it into the mobo's ATX power connector. Of course, to make sure everything powers up again correctly, plug the PSU's ATX connector into the top of the pass-through cable.

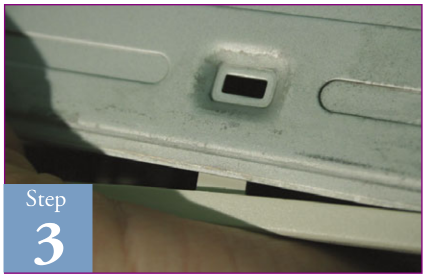
The pass-through cable has a two-hole connector dangling from it. Take this plug and marry it to the two-pronged DC connector on the receiver. Now secure the receiver to an expansion slot on your PC's case. Connect the antenna to the back of the receiver, stand back, and press the Power button on the transmitter. Your computer will spring to life, and because the transmitter has a range of about 30 feet (we made it work from *much* farther away), you can turn the computer on or off, or even start a reset cycle from another room.

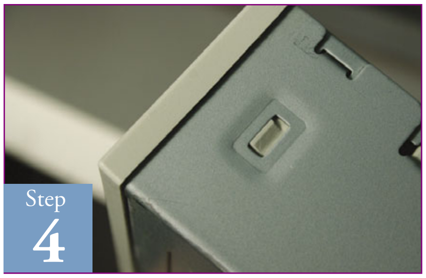
What's the point of having this device installed in your computer? If you ask that question, you obviously don't have enough free time on your hands. If your PC is locked away to prevent intruders (or a mischievous pet) from causing equipment problems, the remote lets you get things started without having to unlock a cabinet every time. The remote might come in handy at a LAN party or similar event. If you get too far behind during a multiplayer game (and your computer happens to be controlling the festivities), use the remote to stealthily reset your machine. Or, if you aren't into unethical gaming, we suppose you can use the remote to start up your PC when you get home from work or school, provided your PC room's walls don't deflect the transmitter's radio signals.

CD-ROM Mod

You might decide that you want different capabilities from your remote. We decided to modify our remote to open our CD-ROM drive tray. This was a straightforward alteration that took only a few minutes to perform, but to complete the job you will need a soldering iron and a drive that you aren't worried about destroying—every drive is a little different and you







will have to do a bit of careful poking and prodding, and we can't guarantee that this process will work with every model.

1 Start by removing the screws that secure the drive to your PC's case. Detach the power and data cables and then remove the drive from the case.

2 Straighten a paper clip and insert the end into the emergency eject hole.

3 Pull the drive tray out just far enough to loosen the bezel. Don't pull any farther than necessary or you might encounter problems with the tray's gears.

4 Plastic tabs secure the drive's front bezel to the metal drive body. Press these tabs inward and pull the bezel off of the drive.

5 You can see where the eject button is attached to the circuit board, but to get at it, you have to remove the metal case surrounding the drive. There are four screws on the bottom of the drive, so remove these with a Philips screwdriver. With these screws out of the way, you can take off the two-part metal case protecting the drive, but before you do, be sure to ground yourself to avoid damaging sensitive electronic parts with accidental electrostatic discharge.

6 Disconnect the receiver's reset wire from its motherboard connector. Use wire cutters to cut off the motherboard connector and then strip one-eighth inch of the wire insulation from the wire tips.

7 Examine the circuit board on the side opposite the eject button. On our drive there were four solder points (two large and two small), and the larger points were basically securing the button to the board. Be-cause of this, we decided to solder our wires to the two smaller points nearer the front of the button.

8 After you solder your Reset button wires to the circuit board, replace the plastic sheet to ward off shorted circuits, reassemble the metal case, replace the bezel, and connect the power and data cables. You might have to get creative to make the Reset wire poke through the CD-ROM drive case and stretch far enough to connect to the receiver. We wormed this wire through a gap in the side of the metal case and set the receiver closer to the middle of the case to make the wire reach, but there's nothing to stop you from splicing in more wire for added length.

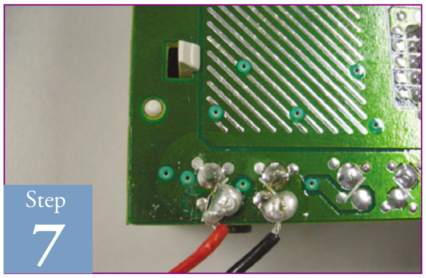
9 Plug the power cable into your PSU and use the remote to start up your PC.

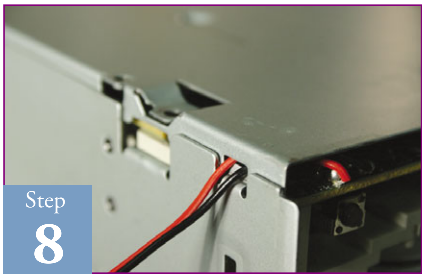
Now, when you press the Reset button on the remote, the CD-ROM drive will open and close. This modification is a little goofy at best, and completely useless to many users, but there are a few potential uses for it. We're always keen on practical jokes, and a CD-ROM drive that won't stay shut will have your friends sharing puzzled sidelong glances.

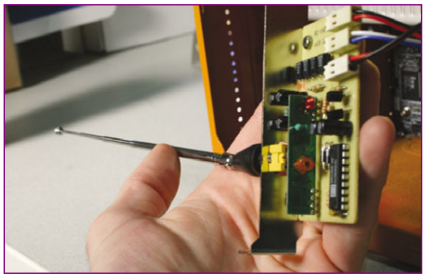
You'll have to use your imagination for other uses. The Autoplay feature in Windows is sure to help. By ejecting and retracting the drive from a distance, an audio CD will start playing on its own, letting you restart Barry White without having to get up from the couch.

Zap It Good

Most users have little need for the remote control capabilities we describe here. Then again, most PC users aren't into overclocking, case modding, and whiling away wee hours of the morning downloading game cheats.







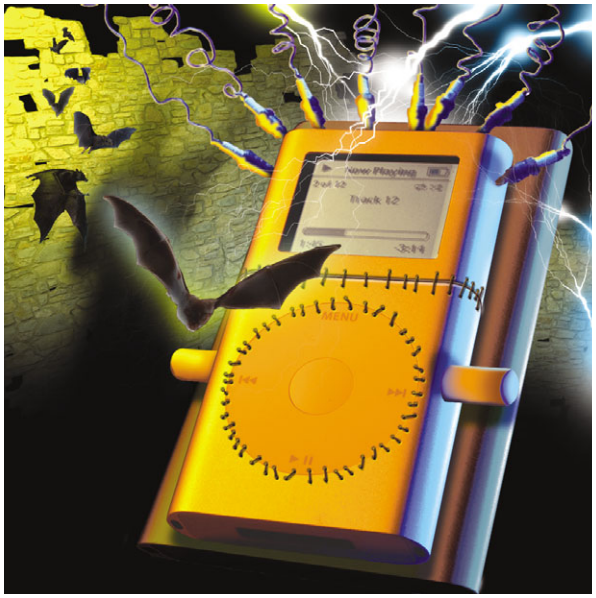
The fully wired receiver supposedly only works if the transmitter is less than 30 feet away, but we had ours kicking into gear from 80 and 90 feet away.

So if you have a vacant expansion slot on the back of your PC case, we recommend buying a Just Cooler remote control kit for your own PC experiments. If you come up with any great ideas, be sure to let us know about it—tell the world about your project on the *CPU* Web site (www.cpumag.com) forums.

by Nathan Chandler

MP3 EVISCERATION

Tear Out That Microdrive & Use It Wherever You Please



Corporate conspirators huddle in secret meetings to discuss profit margins and product pricing markups. Shadowy engineering teams that don't appear on any company payroll cripple their products to save a few bucks. And you, dear reader, ultimately pay the price for the plots of these marauding schemers when you go to buy a Microdrive.

OK, maybe it's not as involved as all that, but there's no doubting one fact. Some of the music-related gizmos you buy contain large-capacity Microdrives—and sell for hundreds less than it would cost you to buy the drive alone. That's why many adept consumers are buying relatively cheap MP3 players, ripping them apart, taking out the Microdrives, and using the drives in other products, such as digital cameras.

As a result, these users snag themselves a high-capacity drive for much cheaper than they would if they'd bought the drive without the MP3 player camouflage. An average 4GB Microdrive sells for about $500. But an MP3 player including pretty much the same drive sells for $200 to $300. Doesn't make much sense, does it? And if you want to cash in and beat the corporate connivers at their own game, there's still time.

Getting The Goods

As of press time, there were two MP3 players at the center of the Microdrive storm: Creative's MuVo2 and Apple's iPod Mini, both of which use 4GB Microdrives to store music audio files.

Every self-respecting geek has heard about the MuVo2 hack, a prime reason that it's unlikely you'll find this player for sale at retail outlets. You have a couple of options to complete the mission-critical MuVo2 purchase. One, you can call Creative and ask to be put on a waiting list because The Fools are still making the player available to the general public, though only on a limited basis. Two, make a bid on eBay where the players are routinely selling for a third more than the typical $200 street price. That's a serious blow to your modding budget, but you owe it to yourself to live a little before They come for you, and even at $300, this product is a steal.

Here are two quick tips on buying a MuVo2. An oft-repeated rumor indicates that some MuVo2 drives are soldered into place, and, thus, nearly impossible to remove. These claims are unsubstantiated falsities perpetuated by Authorities who don't like you subverting The System. Also, if you like the idea of inserting an old CompactFlash card into the MuVo2 so you can have a functional MP3 player, keep in mind that not all brands of CF cards work. If your flash card doesn't do the trick, you can, of course, buy a new card (rumor has it the MuVo2 seems to like SanDisk and Lexar Media cards) or just pawn off the vacant player on eBay.

Before you start Googling to find one of these two products, make sure you read this story in its entirety so you have an idea of how easy or hard it is to disassemble the players and what tasks you can use each drive for. I'll start this story with a summary of the end results.

I invested $200 in a MuVo2 player and $330 in an iPod Mini. After hacking away at both, I wound up with a 4GB flash card for my digital camera, a 4GB drive that works as a portable storage device, a workable MuVo2 player with a transplanted 256MB flash card, and a dead, dead, dead mini iPod.

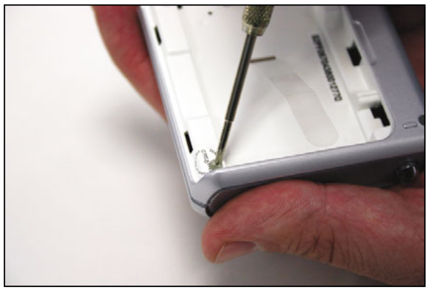
Get Your MuVo On

Gutting the MuVo2 is a piece of cake, and without further adieu, I'll give you the lowdown on slicing and dicing your way to saving at least $200.

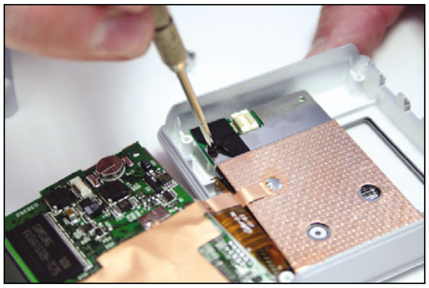
1. Start by downloading the MuVo2's firmware from the Creative Web site using this address: www.nomadworld.com/downloads/firmware/wma-muvo_2_4.asp. As I tapped out these instructions for you, the latest firmware version was 1.11.01, and to ensure success, I advise using this version because They might try to disable the certain capabilities of the Hitachi drive in future firmware versions. If, by odd chance, you receive a MuVo2 that has a firmware version number lower than 1.11.01, you should use the link in this step to upgrade the device's firmware before you attempt any subsequent steps detailed here. Failing to upgrade old versions of the firmware may ruin your chances of successfully hacking the drive, which is exactly what They want. Don't make Them happy.
2. Open the back of the MuVo2 and remove the battery.
3. Consider grounding yourself to eliminate the possibility of damaging static discharge. I didn't actually adhere to

this precaution, but hey, They say I'm technically insane, so what do I know?

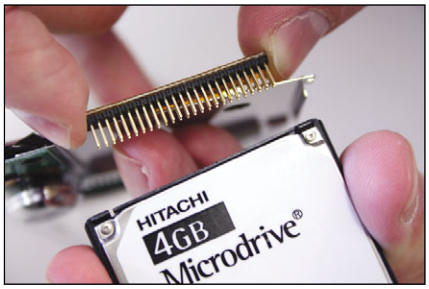
4. Remove the three visible screws from the MuVo2's case. There is a fourth screw on the bottom of the case, and it's conveniently concealed by that nice, friendly WARRANTY VOIDED warning sticker. As if you care, right? I'll mention here that these screws are very small and often hard to remove. That means you might have to use quite a bit of force to take out these screws, but do so with a tender touch, as the plastic case won't endure much abuse.



5. Carefully lift the plastic panel. If you couldn't remove the anger-provoking screws, use necessary force and violence, but keep in mind that even eviscerated (but otherwise undamaged) MuVo2's sell for decent cash on eBay.
6. Because you removed the four screws that secure it, you can gently flip over the circuit board. If you need to apply force, use a flat-tipped screwdriver to carefully pry up the board. Then you see a copper-colored plate that shields the drive. There are four screws holding the drive in place, but only three are visible at first glance. Remove the three you see and then gently peel back the black tape concealing the fourth screw. Do not completely remove the tape, as it holds a small battery in place.



7. Now you can flip up the shielding plate and expose the Microdrive. Lift the Microdrive and use your flat-tipped screwdriver to (again, carefully) slightly separate the Microdrive from the pin array. Don't try to pry out one side of the array all at once—doing so can damage the pins, the drive, or both. After you've sufficiently loosened the pins, pull the drive from its MuVo2 prison and into beautiful, blessed freedom.



8. If your digital camera accepts a CompactFlash Type II card, you should be able to slip the card into the camera, format it, and immediately begin using your huge, new drive.
9. If you want to use your MuVo2 with a CompactFlash card of your choice, now's the time to do the job. Attach the pin array to your CompactFlash card, taking care to properly orient the card (when completely assembled, the card's front label should face the same direction as the front of the MuVo2). If you improperly affix the card, when you power up the MuVo2, you will see only "MuVo2" displayed on the LCD.
10. Reassemble the player. Be sure to smooth down the black tape covering the fourth screw.
11. Insert the battery and power up the MuVo2. It will immediately display a recover mode error message.
12. From the Recovery menu, select Format All, after which you will see a media error message.
13. Now, select Reload Firmware from the MuVo2's menu. Connect the device to your PC using the USB cable and run the firmware upgrade program that you downloaded from Creative's Web site. Then you can use the MuVo2 as you did with the Microdrive inside.

There are few caveats on using the Microdrive from the MuVo2 to capture huge numbers of pictures on your digital camera. Because this is a hard drive, it has moving parts. And because those parts need power to read and write data, some users estimate 25% fewer photos per shooting session due to battery issues. The drive also writes data more slowly than a flash card, which means you won't do much high-speed shooting with this Microdrive. The drive's real appeal is its huge capacity and the fact that you can store thousands of pictures on one tiny piece of electronic equipment.

Mini Me, Me, Me!

Apple's iPod Mini shares some similarities with the MuVo2. It's a compact MP3 player, and it uses a Hitachi Microdrive with a CompactFlash card connector. But where the MuVo2 isn't much more than a glorified plastic box, the iPod Mini is a beautiful work of art with slim lines, a tasteful and tough metal case, and the iPod's legendary scroll wheel. How I yearn to disembowel thee, oh pretty iPod Mini.

I decided to remove the drive and attempt to use it in my camera and CompactFlash card reader. A number of other users have unsuccessfully attempted this task, but I figured what the heck, if I ruin my itty bitty Mini, no big deal, it's just an Apple product.

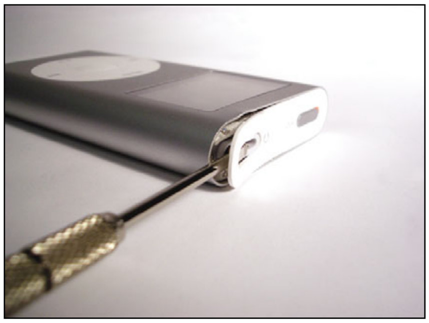
Of course, before you can attempt to make the drive work, you'll have to remove it from the clutches of that nice iPod case. Doing so takes a lot more effort than with the MuVo2, and the benefits of doing so are iffy, which is one reason there hasn't been a MuVo2-like mass hoarding of iPod Minis. Read along, and you'll see how to see how the disassembly works and what you stand to gain.

Core that Apple. The iPod Mini's big selling point is that it offers a whopping 4GB-capacity MP3 player in a miniscule form factor. That means there's a lot of technology under the hood of these tiny players, and as such, you should think twice about taking yours apart. Not only do you take the risk that a part or two will break and render certain features unusable, but at the very least, you'll create cosmetic blemishes on the player. So don't say I didn't warn you, Junior.

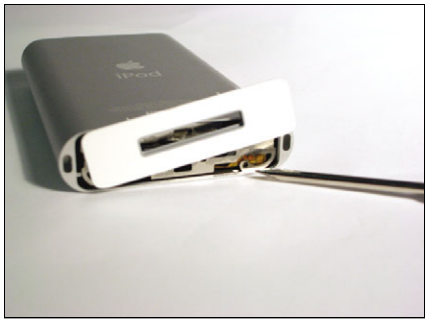
There are only a few tools you need to tear into the iPod, and the most important one is your head. Be wise and try not to use excessive force for any steps in this procedure. Beyond a few brains, you also need a small flat-blade screwdriver, a tiny Phillips screwdriver, and needle-nose pliers. You also need a well-lighted workspace with minimum clutter; otherwise you will end up losing the iPod's tiny parts.

1. Slide the Hold button into the orange (On) position. This keeps the Mini from trying to power up during the dissection. Think of this as anesthesia for a delicate surgical procedure.
2. As odd as it sounds, you don't need anything in the way of tools for the first part of this project. All you need is a way to warm up the Mini. This is to soften the adhesive that binds the Mini's top and bottom plastic plates to the metal body. No, no, take the iPod out of the microwave, Junior. Here, drink this. There are a number of ways to warm up your Mini without resorting to a hellish conflagration. Some users warm the Mini with a hair dryer, but if you don't have one at your disposal, you can set the Mini on that warm spot most ovens create on the center of a stovetop. Or you can put the Mini in a Ziplock bag and run really hot tap water over the whole thing. Whatever you decide on, just don't get the Mini so hot that you get burned. Don't say I didn't warn you because that metal case can get incredibly hot when it feels up to it.

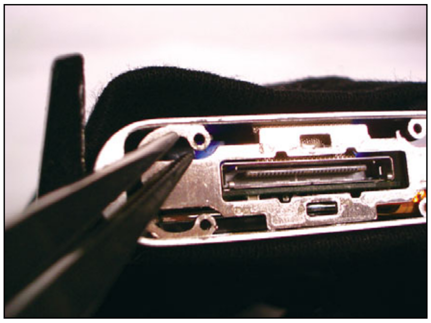
3. Once the case is very warm to the touch, take out your small, flat-bladed screwdriver and turn the iPod Mini so that you're looking at the top area where the Hold button is located. The white plastic is a thin and rather flimsy plate, and it's easy to remove using your screwdriver. The problem is removing this plate without gouging the heck out of the plate or scratching the metal case. Start by squeezing near the top of iPod Mini's rounded sides. If you have enough finger strength, you can bend the metal enough to create a tiny gap for the screwdriver tip. This isn't easy, though, so you might want to use a vise or clamp to apply pressure (just remember to protect the iPod Mini case from scratches by using a soft cloth). Slip the screwdriver in just a little bit on the side opposite the Hold button and pry up the plate carefully, working your way around the end. When you get to the Hold button, be sure not to pry at too much of any angle or you risk breaking the button's subsurface components.



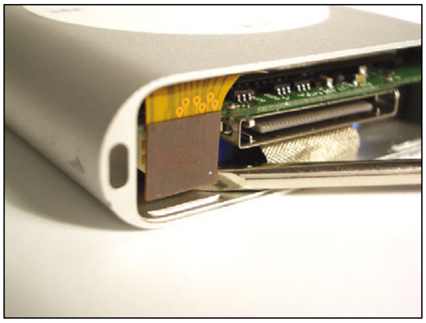
4. Repeat the previous step to remove the bottom plate. This plate is a little easier to remove because there's no Hold button to worry about.



5. Once you remove the bottom plate, you'll see a metal fastener that basically holds the iPod Mini's guts in place. This fastener is nothing complex; it just has four legs that slip into slits in the interior of the Mini's case. To remove this fastener, you need to pull at least two of those legs free. If you have a small enough screwdriver, you can insert the blade into the holes of the fastener and pull the legs free; if you aren't equipped with such a small screwdriver, try using needle-nose pliers instead and start with the legs that don't have underlying obstructions. One of those obstructions is an important data cable that you don't want to gouge.



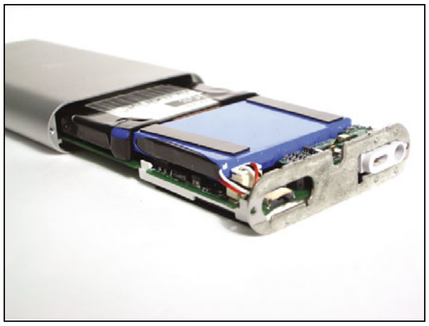
6. With the metal fastener out of the way, you have access to the short data cable that connects the scroll wheel with the main circuit board. The cable is a rusty orange color. Take your flat-blade screwdriver and gently lift up on the connector to pull it free. As with the plastic end plates you removed earlier, take your time and work your way around the edges to make sure you don't cause any damage.



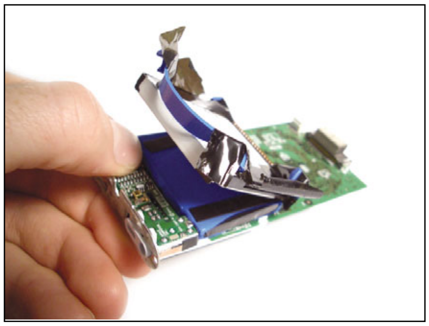
7. Now focus your attention on the other end (top) of the iPod Mini where you removed the Hold button. If you look

closely, you will see two little screws on either side of the Mini's interior. Use your Phillips screwdriver to remove both screws and then put the screws in a safe place. Lose those screws on the carpet, or even on a linoleum floor, and you will likely never see them again.

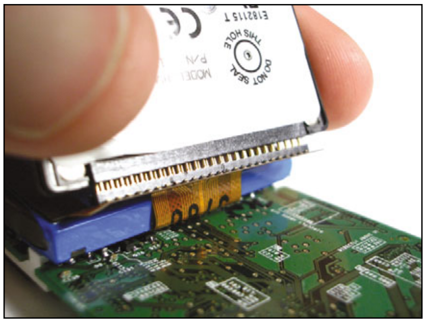
8. Those screws were the last parts securing your iPod Mini's innards, and now those electronic entrails are all but swinging blithely in the breeze. Turn the Mini around so you're looking at it from the bottom and use your thumb to push on the broad connector. The entire inside of the Mini will start to slip out of the top. Push and wiggle these components, and you can see the miniature hard drive that you've worked so diligently to free.



9. Only a strip of black electrical tape secures the drive to its connector on the mainboard. The tape is in one big piece, and it holds a rubber jacket around the drive. To remove the tape, start by peeling away the large center area on both sides of the drive and then peel away the corners.



10. Now all you have to do is pull the drive off of its 30-pin connector. Use your flat-head screwdriver to loosen the connector on both sides and then carefully pull the drive away.



11. If you're an Apple fanatic who can't fathom what possessed you to do such a thing to a beautful iPod, on a bleak, cold night on a bridge overlooking the Hudson, turn your face upward into the rain with the drive clenched tightly in your fist, scream, "WHY, WHY, WHY??" into the foul night air, and cast the drive as far as you can out into the water.

You can use the drive in some flash card readers. I inserted the drive into my Lexar Media USB 2.0 Multi-Card Reader and then formatted the card to use a FAT file system.

I immediately attempted to transfer a few files to the drive and did so successfully, so to confirm that my test did work, I tried to view the files on another Windows XP machine. The drive worked perfectly.

With the Microdrive removed, you can use the 4GB as a massive, portable file transfer system. Of course, you could do the same thing with an intact iPod Mini, and that might actually be preferable to using the drive outside its case—not all card readers will detect the drive, making the advantages of iPod Mini evisceration somewhat dubious.

The 4GB drive won't work in a digital camera. When you insert the drive into a CompactFlash card slot, your camera will either temporarily lock up or display an error message. Apple apparently had Hitachi disable the ability for the drive to work with most devices that use removable storage. When I cornered an Apple representative on a sidewalk outside company headquarters one night, I asked her to tell me exactly what makes the drive inoperable in cameras, but she wielded a can of pepper spray and scurried off to her VW bug while muttering something about "secret iPod magic" and "call 911."

Next, I invited a Hitachi spokesperson to meet with me at a back table in a seedy bar. Of course, I extended the invitation under the guise that I was a large business owner who needed tens of thousands of Microdrives for a new MP3 player, but when the Hitachi rep arrived, I ripped off my mask and demanded to know why the drive didn't do much when parted from the iPod.

The spokesperson, who shall remain anonymous for fear of company retribution, said, "Embedded Microdrive products are manufactured to different specifications than standalone Microdrive products. For example, we may lay microcode in the final manufacturing process specific to needs of a particular device manufacturer. Microcode is software that is stored on the drive and defines the way the drive operates. It is tailored to the requirements of our customers. Users cannot alter the microcode because we do not provide a method to do so." The spokesperson alluded to additional testing and manufacturing alterations used during the creation of the embedded iPod drive, but even after six High Lifes, he wasn't ready to divulge these details. I considered spiking the Hitachi rep's beer with a sleeping pill so that I could drag him back to interrogation, but alas, I no longer have access to that particular government facility.

Keep On MuVo2'n

So, there you have it, the lowdown on cracking open high-tech toys to get at the more expensive and more fun high-tech toys inside. After reading the pros and cons behind MP3 player evisceration, you might opt not to take any risks with yours. For those of you who do rip your players apart, keep your eyes open for upcoming products that are sure to incorporate Hitachi Microdrives, as the company recently boosted production to keep up with high demand. Be mad and mod on. Mwa-ha-ha-haaah!

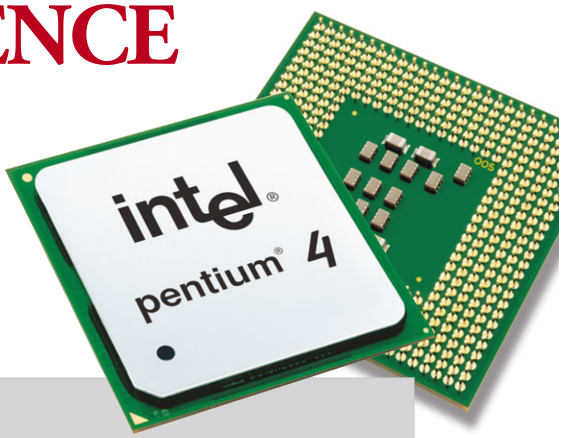
by Mad Modder

INTEL CHIP REFERENCE

Guide to Intel's Newest Processors

Intel has released many new processors during the past six months, including new mobile processors with Centrino technology, a P4 EE, several Prescotts, and a variety of server and workstation CPUs. The following chart is a quick reference to Intel's newest processors.

Compiled by Kylee Dickey



Processor Chart (Listed in reverse chronological order)

Processor Family	Celeron M	Mobile Pentium 4	Mobile Pentium 4	Mobile Pentium 4	Pentium M	Pentium M
Product Name*	340	538	532	518	755	745
Clock Speed	1.5GHz	3.2GHz	3.06GHz	2.8GHz	2GHz (600MHz in Battery Optimized mode)	1.8GHz (600MHz in Battery Optimized mode)
Code Name	Banias	Dothan	Dothan	Dothan	Dothan	Dothan
Date Of Introduction	June 1, 2004	June 1, 2004	June 1, 2004	June 1, 2004	May 10, 2004	May 10, 2004
System Bus	400MHz	533MHz	533MHz	533MHz	400MHz	400MHz
Cache	512KB L2	1MB L2	1MB L2	1MB L2	2MB L2	2MB L2
Socket Type	Socket 478	Socket 478	Socket 478	Socket 478	Socket 478	Socket 478
Manufacturing Technology	0.13-micron	90nm	90nm	90nm	90nm	90nm
Supported Memory	DDR SDRAM	DDR SDRAM	DDR SDRAM	DDR SDRAM	Up to 2GB of DDR	Up to 2GB of DDR
Target Market	Thin and light notebooks	Notebooks, mobile systems	Notebooks, mobile systems	Notebooks, mobile systems	Thin and light notebook PCs	Thin and light notebook PCs
Features	Lower core voltage than Celeron CPUs	HT Technology, 13 new SSE3 extensions, Enhanced Intel SpeedStep technology			Intel Centrino technology, supports notebooks less than 1 inch thick, dedicated stack manager, supports Enhanced Intel Speedstep technology, supports Intel MVP IV, 21W power consumption, 1.276V to 1.34V	
Number Of CPUs Supported	1	1	1	1	1	1

Processor Chart (continued)

Processor Family	Pentium M	Itanium 2	Itanium 2	Ultra Low-Voltage Pentium M	Celeron M	Ultra Low-Voltage Celeron M
Product Name*	735	N/A	N/A	N/A	N/A	N/A
Clock Speed	1.7GHz (600MHz in Battery Optimized mode)	1.6GHz	1.4GHz	1.1GHz	1.4GHz	900MHz
Code Name	Dothan	Madison	Madison	Banias	Banias	Banias
Date Of Introduction	May 10, 2004	May 2004	April 13, 2004	April 7, 2004	April 7, 2004	April 7, 2004
System Bus	400MHz	400MHz	400MHz	400MHz	400MHz	400MHz
Cache	2MB L2	3MB L3	3MB L3, 256KB L2, 32KB L1 (instruction and data)	1MB L2	512KB L2	512KB L2
Socket Type	Socket 478	Itanium 2	Itanium 2	Socket 478	Socket 478	Socket 478
Manufacturing Technology	90nm	0.13-micron, 410 million transistors	0.13-micron, 410 million transistors	0.13-micron, 77 million transistors	0.13-micron, 77 million transistors	0.13-micron, 77 million transistors
Supported Memory	Up to 2GB of DDR	DDR SDRAM	DDR SDRAM	Up to 2GB of DDR	DDR SDRAM	DDR SDRAM
Target Market	Thin and light notebook PCs	Dual-processor servers in clusters, high-performance applications, technical applications		Mobile computers	Mobile computers	Mobile computers
Features	Intel Centrino technology, supports notebooks less than 1 inch thick, dedicated stack manager, supports Enhanced Intel Speedstep technology, supports Intel MVP IV, 21W power consumption, 1.276V to 1.34V	EPIC architecture; MCA with ECC; IA-32 EL; support for HP-UX, Linux, and Windows Server 2003	EPIC architecture; MCA with ECC; IA-32 EL; support for HP-UX, Linux, and Windows Server 2003	Centrino technology, Micro-Ops Fusion, dedicated stack manager	SSE2, low-power states including Deep Sleep	SSE2, low-power states including Deep Sleep
Number Of CPUs Supported	1	1, 2	1, 2	1	1	1

*New Intel naming system, which does not apply to the older CPUs in this chart

Processor Chart (continued)

Processor Family	Low-Voltage Pentium M	Xeon MP	Xeon MP	Xeon MP	Pentium 4	Pentium 4
Product Name*	N/A	N/A	N/A	N/A	N/A	N/A
Clock Speed	1.3GHz	2.2GHz	2.7GHz	3GHz	2.80E GHz	3.0E GHz
Code Name	Banias	Gallatin	Gallatin	Gallatin	Prescott	Prescott
Date Of Introduction	April 7, 2004	March 2, 2004	March 2, 2004	March 2, 2004	Feb. 2, 2004	Feb. 2, 2004
System Bus	400MHz	400MHz	400MHz	400MHz	800MHz	800MHz
Cache	1MB L2	2MB L3	2MB L3	4MB L3	1MB L2	1MB L2
Socket Type	Socket 478	Socket 603	Socket 603	Socket 603	Socket 478	Socket 478
Manufacturing Technology	0.13-micron, 77 million transistors	0.13-micron, 169 million transistors	0.13-micron, 169 million transistors	0.13-micron, 169 million transistors	90nm, 125 million transistors	90nm, 125 million transistors
Supported Memory	Up to 2GB of DDR	Dual-channel DDR	Dual-channel DDR	Dual-channel DDR	Dual-channel DDR 333/266 SDRAM	Dual-channel DDR 400/333/266 SDRAM
Target Market	Mobile computers	Multiprocessor midtier and back-end servers	Multiprocessor midtier and back-end servers	Multiprocessor servers with four processors	Desktop PCs and entry-level workstations	
Features	Centrino technology, Micro-Ops Fusion, dedicated stack manager	HT Technology, Intel NetBurst architecture, rapid-execution engine, SSE2	HT Technology, Intel NetBurst architecture, rapid-execution engine, SSE2	HT Technology, Intel NetBurst architecture, rapid-execution engine, SSE2	Intel NetBurst microarchitecture, SSE2, SSE3, Intel RAID Technology available (with Intel 875P, 865PE, 865P, and 865G chipsets with ICH5R), HT Technology, 128-bit floating point port, thermal monitoring, BIST, IEEE 1149.1 standard test access port and boundary scan	
Number Of CPUs Supported	1	2, 4, 8	2, 4, 8	2, 4, 8	1	1

Processor Chart (continued)

Processor Family	Pentium 4	Pentium 4	Pentium 4	Pentium 4 Extreme Edition	Mobile Celeron	Celeron
Product Name*	N/A	N/A	N/A	N/A	N/A	N/A
Clock Speed	3.2E GHz	3.4E GHz	3.4GHz	3.4GHz	2.5GHz	2.8GHz
Code Name	Prescott	Prescott	Northwood	Gallatin	Northwood	Northwood
Date Of Introduction	Feb. 2, 2004	Feb. 2, 2004	Feb. 2, 2004	Feb. 2, 2004	Nov. 12, 2003	Nov. 5, 2003
System Bus	800MHz	800MHz	800MHz	800MHz	400MHz	400MHz
Cache	1MB L2	1MB L2	512KB L2 ATC	2MB L3,512KB L2	256KB L2	128KB L2 ATC
Socket Type	Socket 478	Socket 478	Socket 478	Socket 478	Socket 478	Socket 478
Manufacturing Technology	90nm, 125 million transistors	90nm, 125 million transistors	0.13-micron, 55 million transistors	0.13-micron, 178 million transistors	0.13-micron	0.13-micron
Supported Memory	Dual-channel DDR 400/333/266 SDRAM	Dual-channel DDR 400/333/266 SDRAM	Dual-channel DDR 400/333/266 SDRAM	Dual-channel DDR 400/333/266 SDRAM	SDRAM or DDR SDRAM (when used with the Intel 852G chipset)	RDRAM or DDR RAM (dependent upon chipset)
Target Market	Desktop PCs and entry-level workstations			Computing enthusiasts and gamers	Value notebooks	Value PCs
Features	Intel NetBurst microarchitecture, SSE2, SSE3, Intel RAID Technology available (with Intel 875P, 865PE, 865P, and 865G chipsets with ICH5R), HT Technology, 128-bit floating point port, thermal monitoring, BIST, IEEE 1149.1 standard test access port and boundary scan	Intel NetBurst microarchitecture, SSE2, SSE3, Intel RAID Technology available (with Intel 875P, 865PE, 865P, and 865G chipsets with ICH5R), HT Technology, 128-bit floating point port, thermal monitoring, BIST, IEEE 1149.1 standard test access port and boundary scan	Intel NetBurst microarchitecture, SSE2, SSE3, Intel RAID Technology available (with Intel 875P, 865PE, 865P, and 865G chipsets with ICH5R), HT Technology, 128-bit floating point port, thermal monitoring, BIST, IEEE 1149.1 standard test access port and boundary scan	Intel NetBurst microarchitecture, SSE2, SSE3, Intel RAID Technology available (with Intel 875P, 865PE, 865P, and 865G chipsets with ICH5R), HT Technology, 128-bit floating point port, thermal monitoring, BIST, IEEE 1149.1 standard test access port and boundary scan	SIMD extensions and QuickStart technology	Data flow analysis, speculative execution, nonblocking L1 cache, Internet Streaming SIMD extensions, DIB, and Intel MMX technology
Number Of CPUs Supported	1	1	1	1	1	1

Intel Processor Roadmap (2004 & Beyond)

According to Intel's roadmaps, there will be a number of new processors released during 2004, many manufactured with 90nm technology. Intel also has a number of Itanium 2s ready to roll out this year. Below are the details that were available at press time.

Workstations	**Name**	**Clock Speed**	**Manufacturing Technology**	**Cache**	**Chipset Compatibility**	**Other Details**
Q1-Q2 2004	Itanium 2 for Workstations (Madison)	1.4GHz	0.13-micron	1.5MB L3	Enabled chipset	
Q1-Q2 2004	Itanium 2 for Workstations	1GHz	0.13-micron	1.5MB L3	Enabled chipset	Low-voltage
Q1-Q2 2004	Xeon for Workstations (Nocona)	At least 3.4GHz	90nm		Intel E7505 or enabled chipset	
Q3-Q4 2004	Itanium 2 for Workstations	At least 1.4GHz	0.13-micron	At least 1.5MB L3	Enabled chipset	
Q3-Q4 2004	Itanium 2 for Workstations	At least 1GHz	0.13-micron	At least 1.5MB L3	Enabled chipset	Low-voltage
Q3-Q4 2004	Xeon for Workstations	At least 3.6GHz	90nm		Next-generation chipset	

Mobile Processors	**Name**	**Clock Speed**	**Manufacturing Technology**	**Cache**	**Chipset Compatibility**	**Other Details**
Q1-Q2 2004	Mobile Celeron	2.8GHz			Intel 852PM/GM	
Q1-Q2 2004	Celeron M Banias (Intel 310)	1.2GHz	0.13-micron	512KB L2	Intel 855PM/GM/GME and 852GML	400MHz FSB
Q2 2004	Pentium M	1.7GHz	90nm	2MB L2	Intel 855PM/GM/GME	Centrino technology, PRO/Wireless 2100A and 2200BG connectivity, 400MHz FSB
Q2 2004	Pentium M	1.8GHz	90nm	2MB L2		400MHz FSB
Q2-Q3 2004	Celeron M Banias (Intel 320)	1.3GHz	0.13-micron	512KB	Intel 855PM/GM/GME and 852GML	400MHz FSB
Q2-Q3 2004	Celeron M Banias (Intel 330)	1.4GHz	0.13-micron	512KB	Intel 855PM/GM/GME and 852GML	400MHz FSB
Q3 2004	Pentium M (Intel 725)	1.6GHz	90nm	2MB L2		400MHz FSB
Q3 2004	Pentium M	2.0GHz	90nm	2MB L2		400MHz FSB
Q3-Q4 2004	Pentium M (Intel 730)	1.6GHz	90nm	2MB L2		533MHz FSB
Q3-Q4 2004	Ultra Low Voltage Pentium M (Intel 733)	1.1GHz	90nm	2MB L2		400MHz FSB
Q3-Q4 2004	Mobile Celeron	At least 2.8GHz			Intel 852PM/GM	
Q3-Q4 2004	Celeron M (Intel 350)	1.3GHz	90nm	1MB L2	Next-generation mobile chipset	400MHz FSB
Q3-Q4 2004	Ultra Low-Voltage Celeron M (Intel 353)	900MHz	0.13-micron	512KB L2		400MHz FSB
Q3-Q4 2004	Celeron M (Intel 360)	1.4GHz	90nm	1MB L2		400MHz FSB
Q3-Q4 2004	Celeron M (Intel 370)	1.5GHz	90nm	1MB L2		400MHz FSB
Q3-Q4 2004	Ultra Low-Voltage Celeron M (Intel 373)	1GHz	90nm	512KB L2		400MHz FSB
Q3-Q4 2004	Low-Voltage Pentium M (Intel 738)	1.4GHz	90nm	2MB L2		400MHz FSB
Q4 2004	Pentium M	1.6GHz	90nm	2MB L2		533MHz FSB
Q4 2004	Pentium M (Intel 740)	1.73GHz	90nm	2MB L2		533MHz FSB
Q4 2004	Pentium M (Intel 750)	1.86GHz	90nm	2MB L2		533MHz FSB
Q4 2004	Ultra Low-Voltage Pentium M (Intel 753)	1.2GHz	90nm	2MB L2		400MHz FSB
Q4 2004	Low-Voltage Pentium M (Intel 758)	1.5GHz	0.13-micron	2MB L2		400MHz FSB
Q4 2004	Pentium M (Intel 760)	2.0GHz		2MB L2		533MHz FSB
Q4 2004	Pentium M (Intel 770)	2.13GHz	90nm	2MB L2		533MHz FSB
2005	Unknown					Mobile processors based on Pentium 4 core will be replaced by dual-core notebook processors.
2005 or 2006	Merom					Mobile processor based on a new core.
Late 2006	Conroe					Faster version of Merom.

Intel Processor Roadmap (continued)

Desktop Processors	Name	Clock Speed	Manufacturing Technology	Cache	Chipset Compatibility	Other Details
Q1-Q2 2004	Pentium 4	At least 3.4GHz				3.4GHz P4 with 90nm technology released on Feb. 2, 2004.
Q1-Q2 2004	Celeron	At least 2.8 GHz			Intel 845 chipset family	2.8GHz Celeron released on Nov. 5, 2003.
Q2 2004	Pentium 4	3GHz	90nm	1MB L2		Socket 775, 800MHz FSB
Q2 2004	Pentium 4	3.2GHz	90nm	1MB L2		Socket 775, 800MHz FSB
Q2 2004	Pentium 4	3.4GHz	90nm	1MB L2	Intel 845, 865, 875P, and next-generation chipset	Socket 775, 800MHz FSB
Q2 2004	Pentium 4	3.6GHz	90nm	1MB L2		Socket 775, 800MHz FSB
Q2 2004	Pentium 4 Extreme Edition (Northwood core)	3.4GHz	0.13-micron			Socket 775
Q3-Q4 2004	Pentium 4 Copper River	At least 3.6GHz			Intel 845, 865, and 875P chipset families and next-generation chipset	
Q3-Q4 2004	Celeron (Prescott core)	At least 3.06GHz			Intel 845 chipset family	
Q3 2004	Pentium 4	3.8GHz	90nm	1MB L2		Socket 775, 800MHz FSB
Q3 2004	Pentium 4 (Intel 720, Prescott)	3.73GHz	90nm	2MB L2		1,066MHz FSB
Q3 2004	Celeron (Intel 335)	2.8GHz	90nm	256KB L2		Socket 775, 533MHz FSB
Q3 2004	Celeron (Intel 340)	2.93GHz	90nm	256KB L2		Socket 775, 533MHz FSB
Q3 2004	Celeron (Intel 345)	3.06GHz	90nm	256KB L2		Socket 775, 533MHz FSB
Q3 2004	Celeron (Intel 350)	3.2GHz	90nm	256KB L2		Socket 775, 533MHz FSB
Q3 2004	Pentium 4 Extreme Edition (Gallatin core)	3.46GHz				LGA775; 1,066MHz FSB
Q4 2004	Pentium 4 (Intel 580)	4.0GHz	90nm	1MB L2		Socket 775, 800MHz FSB
Q4 2004	Celeron	3.33GHz	90nm	256KB L2		Socket 775, 533MHz FSB

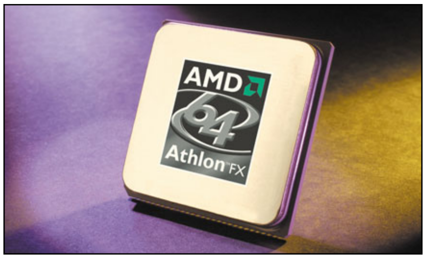
Servers	Name	Clock Speed	Manufacturing Technology	Cache	Chipset Compat	Other Details
Q1-Q2 2004	Itanium 2 for Servers (Madison)	1.5GHz	0.13-micron	6MB L3	Intel E8870	At least eight-way
Q1-Q2 2004	Itanium 2 for Servers	1.5GHz	0.13-micron	6MB L3	Intel E8870	Four-way
Q1-Q2 2004	Itanium 2 for Servers	1.4GHz	0.13-micron	1.5MB L3	Intel E8870	Two-way
Q1-Q2 2004	Itanium 2 for Servers	1GHz	0.13-micron	1.5MB L3	Intel E8870	Two-way, low-voltage
Q1-Q2 2004	Xeon MP for Servers (Gallatin)	At least 3GHz	0.13-micron	At least 4MB L3	Enabled chipset	At least eight-way
Q1-Q2 2004	Xeon MP for Servers	At least 3GHz	0.13-micron	At least 4MB L3	Third-party/enabled chipset	Four-way
Q1-Q2 2004	Xeon for Servers (0.13-micron Prestonia and 90nm Nocona)	At least 3.4GHz	0.13-micron, 90nm		Intel E7501 and next-generation chipset	Two-way
Q3-Q4 2004	Itanium 2 for Servers	1.5GHz	0.13-micron	9MB L3	Intel E8870	At least eight-way
Q3-Q4 2004	Itanium 2 for Servers	1.5GHz	0.13-micron	9MB L3	Intel E8870	Four-way
Q3-Q4 2004	Itanium 2 for Servers	At least 1.4GHz	0.13-micron	At least 1.5MB L3	Intel E8870	Two-way
Q3-Q4 2004	Itanium 2 for Servers	At least 1GHz	0.13-micron	At least 1.5MB L3	Intel E8870	Two-way, low-voltage
Q3-Q4 2004	Xeon MP for Servers	At least 3GHz	0.13-micron	At least 4MB L3	Enabled chipset	At least eight-way
Q3-Q4 2004	Xeon MP for Servers	At least 3GHz	0.13-micron	At least 4MB L3	Enabled chipset	Four-way
Q3-Q4 2004	Xeon for Servers	At least 3.6GHz			Next-generation chipset	Two-way
2005	Unknown-Intel dropped plans for Jayhawk (a Xeon processor) on May 7, 2004.					
Q1 2005	Potomac					Eight-way
Q3 2005	Millington 400/533					64-bit
Q3 2005	Low-Voltage Millington					64-bit

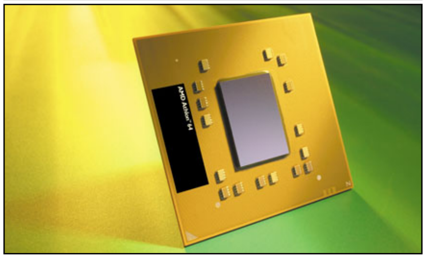
AMD CHIP REFERENCE

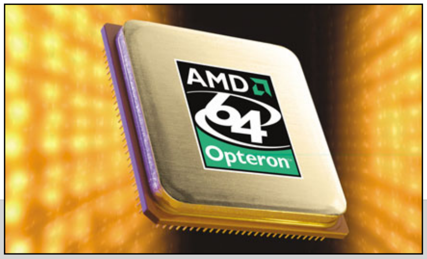
CPU Manufacturer Extends Its Athlon 64, Opteron & Mobile Lines

Since the last issue of *PC Modder*, AMD has released several new processors, including a new Athlon 64, Athlon XP-M, Athlon 64 FX, and several Opterons, including EE (Energy Efficient) and HE (Highly Efficient) models. Here's a guide to AMD's newest CPUs.

Compiled by Kylee Dickey







Processor Reference Chart

Processor Family	Athlon 64 FX	Athlon 64	Athlon 64	Athlon 64	Opteron	Opteron
Model Name	FX-53	3800+	3700+	3500+	850	250
Code Name	NewCastle	NewCastle	Clawhammer	NewCastle	Sledgehammer	Sledgehammer
Date of Introduction	June 1, 2004	June 1, 2004	June 1, 2004	June 1, 2004	Announced: May 18, 2004 Available by: June 17, 2004	May 18, 2004
Data Bus Bit Width	64	64	64	64	64	64
Clock Speed	2.4GHz	2.4GHz	2.4GHz	2.2GHz	2.4GHz	2.4GHz
FSB	2GHz	2GHz	2GHz	2GHz	2.4GHz	2.4GHz
System Bus (effective)	400MHz	400MHz	400MHz	400MHz	2.4GHz	2.4GHz
Cache	128KB L1, 1MB L2	512KB L2	1MB L2	512KB L2	1MB L2	1MB L2
Socket Type	Socket 939	Socket 939	Socket 754	Socket 939	Socket 940	Socket 940
Process Technology	0.13-micron	0.13-micron	0.13-micron	0.13-micron	0.13-micron	0.13-micron
Transistors (in millions)	105.9	105.9	68.5	105.9	About 100	About 100
Supported Memory	Unbuffered PC3200/PC2700 /PC2100/PC1600 DDR	Up to 6.4GBps of PC3200/PC2700 /PC2100/PC1600 DDR unbuffered	Up to 6.4GBps of PC3200/PC2700/ PC2100/PC1600 DDR unbuffered	Up to 6.4GBps of PC3200/PC2700 /PC2100/PC1600 DDR unbuffered	PC1600, PC2100, PC2700, PC3200 DDR	PC1600, PC2100, PC2700, PC3200 DDR
Target Market	Gaming and graphics systems	Systems that need to run cool while still handling high-end graphics	Mainstream PCs	Systems that need to run cool while still handling high-end graphics	Multiprocessor systems, enterprise-level servers	Dual-processor systems, enterprise-level servers
Features	New Socket 939, 2,000MHz HyperTransport (8GBps), 128-bit data path to integrated north bridge, 3DNow! Professional, SSE2	New Socket 939, Cool'n'Quiet technology, 2,000MHz HyperTransport	1MB L2 cache, integrated DDR memory controller, 1,600MHz HyperTransport	New Socket 939, Cool'n'Quiet technology, 2,000MHz HyperTransport	HyperTransport Technology, 64-bit enabled, Direct Connect Architecture, SSE, SSE2	HyperTransport Technology, 64-bit enabled, Direct Connect Architecture, SSE, SSE2
Number of CPUs Supported	1	1	1	1	up to 8	up to 2

AMD Processor Roadmap

AMD's future plans start with the release of a 0.13-micron Athlon 64 processor (known as Newcastle) and a 0.13-micron Mobile Athlon 64 in the first half of 2004. Following these releases, AMD plans to introduce new Opteron, Athlon 64 FX, Athlon XP, and Athlon XP-M chips. Here's a hint of what you can expect from AMD over the next year and a half.

Processor Family	Code Name	Manufacturing Technology	Other Details
Athlon 64 FX			
Q3 - Q4 2004	San Diego	90nm	
Q3 - Q4 2005	Toledo	90nm	
Athlon 64			
Q3 - Q4 2004	Winchester	90nm	
Athlon XP			
Q3 - Q4 2004	Paris	0.13-micron	
Q3 - Q4 2005	Palermo	90nm	
Mobile Athlon 64			
Q3 - Q4 2004	Odessa	90nm	
Q1 - Q2 2005	Oakville	90nm	
Athlon XP-M			
Q3 - Q4 2004	Dublin	0.13-micron	
Q3 - Q4 2005	Trinidad	90nm	
Opteron			
Q3 - Q4 2004	Athens	90nm	Full & Low Power, supports up to 8 CPUs
Q3 - Q4 2004	Troy	90nm	Full & Low Power, supports 1 or 2 CPUs
Q3 - Q4 2004	Venus	90nm	Full & Low Power, supports 1 CPU
Q3 - Q4 2005	Egypt	90nm	
Q3 - Q4 2005	Italy	90nm	
Q3 - Q4 2005	Denmark	90nm	

Opteron	Low Power Mobile Athlon 64	Low Power Mobile Athlon 64	Athlon 64 FX	Athlon XP-M	Opteron	Opteron	Mobile Athlon 64
150	2800+	2700+	FX-53	2100+	840 EE	846 HE	2800+
Sledgehammer	Clawhammer	Clawhammer	Sledgehammer	Barton	Sledgehammer	Sledgehammer	Clawhammer
Announced: May 18, 2004 Available by: June 17, 2004	May 3, 2004	May 3, 2004	Mar. 18, 2004	Mar. 17, 2004	Feb. 17, 2004	Feb. 17, 2004	Jan. 6, 2004
64	64	64	64/32	32	64/32	64/32	64/32
2.4GHz	1.8GHz	1.6GHz	2.4GHz	1.6GHz	1.4GHz	2GHz	1.6GHz
2.4GHz	1.6GHz	1.6GHz	1.6GHz	266MHz	1.6GHz	1.6GHz	1.6GHz
2.4GHz	400MHz	400MHz	400MHz	266MHz	1.6GHz	1.6GHz	400MHz
1MB L2	128KB (64KB + 64KB) L1, 512KB L2	128KB (64KB + 64KB) L1, 512KB L2	1MB L2, 128KB L1	512KB L2, 128KB L1	1MB L2, 128KB (64KB + 64KB) L1	1MB L2, 128KB (64KB + 64KB) L1	1MB L2, 128KB (64KB + 64KB) L1
Socket 940	Socket 754	Socket 754	Socket 940	Socket A	Socket 940	Socket 940	Socket 754
0.13-micron	0.13-micron	0.13-micron	0.13-micron	0.13-micron	0.13-micron	0.13-micron	0.13-micron
About 100	68.5	68.5	105.9	37.5	About 100	About 100	105.9
PC1600, PC2100, PC2700, PC3200 DDR	PC3200, PC2700, PC2100, and PC1600 DDR unbuffered memory at up to 3.2GBps	PC3200, PC2700, PC2100, and PC1600 DDR unbuffered memory at up to 3.2GBps	PC3200, PC2700, PC2100, PC1600 registered DDR	PC-133, DDR SDRAM	PC1600 to PC2700 registered ECC DDR	PC1600 to PC2700 registered ECC DDR	PC3200, PC2700, PC2100, PC1600 DDR unbuffered
Single-processor workstations and entry-level workstations	Notebook PCs	Notebook PCs	Gaming and graphics systems	Thin, light, and mainstream or value notebooks	Blade servers	Blade servers	Notebook PCs
HyperTransport Technology, 64-bit enabled, Direct Connect Architecture, SSE, SSE2	Integrated northbridge, HyperTransport support, 64-bit support, integrated MCT, PowerNow! technology, PowerNoW!, 3DNow!, SSE2, 35W power consumption	Integrated northbridge, HyperTransport support, 64-bit support, integrated MCT, PowerNow! technology, PowerNoW!, 3DNow!, SSE2, 35W power consumption	64-bit, built-in virus protection when used with SP2, noncoherent HyperTransport link, 3DNow!, SSE2	Low-power, AMD PowerNow! for longer battery life, 3DNow!	Eight-way, low-power	Eight-way, low-power	HyperTransport Technology, AMD PowerNow! Technology
1	1	1	1	1	1 to 8 (varies)	1 to 8 (varies)	1

INTEL-COMPATIBLE CHIPSET REFERENCE

Several Chipsets Add Features To Intel-Based Systems

Chipset manufacturers have released a handful of new Intel-compatible chipsets in the past six months, but the real boom in Intel chipsets is likely to happen after the June release of Intel's 915 (Grantsdale) and 925 (Alderwood) chipsets. In the meantime, ATI, SiS, and VIA have spent the winter and spring months releasing chipsets that are compatible with Pentium 4 and Celeron processors. The following charts offer a quick guide to the northbridge and southbridge features of each.

Compiled by Kylee Dickey

ATI

	RADEON 9100 PRO IGP
Date Of Introduction	May 3, 2004
Compatible Intel Processors	Pentium 4, Celeron
Northbridge Features	RADEON 9100 PRO IGP
System Bus	800MHz
Supported Memory	Up to 4GB unbuffered dual-channel, 128-bit DDR400 SDRAM
Integrated Graphics	Yes
External Graphics	AGP 8X with FastWrite
Video Acceleration	Yes
Dual Monitor Support	Yes
Video Capture Ports	Yes
HT Support	Yes
North/Southbridge Link	A-Link
Features	UMA, Pixel Shader 1.4 support, 3D textures support, supports displays up to 2,048 x 1,536 pixels at 32bpp, FSAA, MPEG-2 decoding, video deblocking, support for DVI/DFP, and VESA P&D through external TMDS, supports LCDs of up to 1,600 x 1,200 pixels, composite support, S-Video support, RGB-interface support
Target Market	Gaming and multimedia PCs
Southbridge Features	IXP 300
IDE Support	Two independent IDE channels with Mode 0 and Mode 4 support and ATA 100
SATA	Up to two SATA ports
USB Ports	Up to eight Hi-Speed USB 2.0 ports
Audio	AC'97
Network Support	Gigabit Ethernet
RAID/JBOD	RAID 0
Features	HT support, Gigabit Ethernet, RAID
Target Market	Gaming and multimedia PCs

SiS

	SiS 656	
Date Of Introduction	March 18, 2004	
Compatible Intel Processors	Pentium 4 with up to 800MHz FSB and HT Technology	
Northbridge Features	SiS656	
System Bus	800MHz/533MHz/400Mhz	
Supported Memory	Up to 1GB dual-channel DDR2-667 (up to 10.6GBps) or dual-channel DDR400 (up to 6.4GBps) through four DIMMs, ECC or non-ECC	
Integrated Graphics	N/A	
External Graphics	PCI-Express x16 (4GBps)	
Video Acceleration	No	
Dual Monitor Support	No	
Video Capture Ports	No	
HT Support	Yes	
North/Southbridge Link	MuTIOL 1GB (1GBps)	
Features	PCI-Express x16, support for DDR2, 8-channel audio, eight Hi-Speed USB 2.0 ports, HyperStreaming Technology, and RAID 0, RAID 1, RAID 0+1, and JBOD. Can pair with SiS965 or SiS965L southbridge	
Target Market	Digital and home entertainment systems with PCI-Express x16	
Southbridge Features	SiS965 (introduced Feb. 25, 2004)	965L
IDE Support	ATA 133	ATA 133
SATA	Integrated SATA controller with support for up to four ports	Two port
USB Ports	Support for eight Hi-Speed USB 2.0 ports	Support for eight Hi-Speed USB 2.0 ports
Audio	8-channel, AC'97	8-channel, AC'97
Network Support	Gigabit Ethernet, 1/10Mbps HomePNA	10/100Base-T Ethernet
RAID/JBOD	RAID 0, 1, 0+1, JBOD	RAID 0, 1, JBOD
Features	Supports two PCI-Express x1 ports, 8-channel audio, Gigabit Ethernet, RAID	Supports two PCI-Express x1 ports, 8-channel audio, RAID
Target Market	Systems with PCI-Express x16 and networked systems	Systems with PCI-Express x16

VIA

	PM880 (IG)	PM800 (IG)
Date Of Introduction	March 12, 2004	March 12, 2004
Compatible Intel Processors	Pentium 4	Pentium 4
Northbridge Features	PM880 (IG)	PM800 (IG)
System Bus	800MHz FSB	800MHz FSB
Supported Memory	Up to 8GB of dual-channel DDR400	Up to 8GB of single-channel DDR400
Integrated Graphics	UniChrome Pro	UniChrome Pro
External Graphics	AGP 8X	AGP 8X
Video Acceleration	Yes	Yes
Dual Monitor Support	Yes	Yes
Video Capture Ports	Yes	Yes
HT Support	Yes	Yes
North/Southbridge Link	Ultra V-Link (1GBps)	Ultra V-Link (1GBps)
Features	S3 Graphics UniChrome Pro IGP graphics core, 3D graphics engine, Chromotion CE Video Display Engine, up to 1080p-resolution HDTV, integrated MPEG-2 decoding, adaptive deinterlacing, video deblocking, DualStream 64 memory controller	S3 Graphics UniChrome Pro IGP graphics core, 3D graphics engine, Chromotion CE Video Display Engine, up to 1080p-resolution HDTV, integrated MPEG-2 decoding, adaptive deinterlacing, video deblocking, FastStream 64 memory controller
Target Market	HDTV-ready PCs, small-form-factor PCs, mainstream multimedia PCs	HDTV-ready PCs, small-form-factor PCs, mainstream multimedia PCs
Southbridge Features	VT8237 (previously released)	VT8237 (previously released)
IDE Support	ATA 133	ATA 133
SATA	Supports two additional SATA devices	Supports two additional SATA devices
USB Ports	Supports eight Hi-Speed USB 2.0 ports	Supports eight Hi-Speed USB 2.0 ports
Audio	Integrated VIA Vinyl Audio with 5.1 surround sound, VIA Vinyl Gold 8-channel Audion (PCI)	Integrated VIA Vinyl Audio with 5.1 surround sound, VIA Vinyl Gold 8-channel Audion (PCI)
Network Support	10/100Base-T Ethernet	10/100Base-T Ethernet
RAID/JBOD	RAID 0, RAID 1, RAID 0+1	RAID 0, RAID 1, RAID 0+1
Features	HT support, 5.1- or 8-channel audio, RAID	HT support, 5.1- or 8-channel audio, RAID
Target Market	Upper-mainstream PCs	Upper-mainstream PCs

Chipset Roadmap

Among the most anticipated Intel-compatible chipsets are Intel's 915 (Grantsdale) and 925 (Alderwood) chipsets, which will support PCI-Express x16, HD Audio, and other features. Although Intel will likely lead the march, other manufacturers, including ATI, SiS, and VIA have their own Intel-compatible chipsets planned.

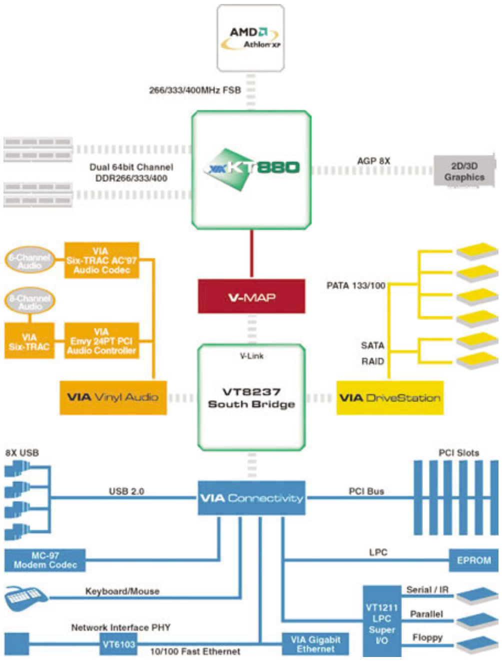
	Name	Compatible Processors	Northbridge Features	Southbridge Features
2004	ATI RADEON 9000 PRO IGP	Pentium 4, Celeron	Single-channel DDR support	N/A
Q2 2004	Intel E7710 (Lindenhurst)	Xeon	Designed for one- or two-way servers and workstations, 667MHz FSB	N/A
Q2 2004	Intel E7515 (Tumwater)	Xeon	PCI-Express x16	N/A
Q2 2004	VIA PT890	Pentium 4	800MHz FSB, dual 64-bit memory bus width, DDR 266/333/400 SDRAM with ECC and DDR2 400/533/667 with ECC support, AGP 8X external graphics support, PCI Express x16/x4 external graphics support	N/A
Q2 2004	VIA VT8251	N/A - compatible with any VIA northbridge chip	N/A	Two PATA ports (four devices); four SATA ports; RAID 0, RAID 1, RAID 0+1, JBOD; support for up to eight Hi-Speed USB 2.0 ports; PCI Express 1x external graphics support; 8-channel audio, 6-channel AC'97 audio; Gigabit Ethernet
June 2004	Intel 915 (Grantsdale)	Pentium 4	Dual-channel DDR2 and dual-channel DDR support, Extreme Graphics 3 with 915G chipset, PCI Express x16	ICH6-R/-W provide up to eight SATA ports; RAID 0, 1, 0+1; HD Audio; ICH6-W provides integrated WAP
June 2004	Intel 925 (Alderwood)	Pentium 4 Extreme Edition	Supports Pentium 4 Extreme Edition processors	ICH6-RW provides up to four SATA ports, Intel Wireless Connect Technology, eight Hi-Speed USB 2.0 ports, HD Audio
June 2004	Intel ICH6-R	Pentium 4	N/A	i915 compatibility; RAID 0, 1, 0+1; Gigabit Ethernet; HD Audio
June 2004	Intel ICH6-W	Pentium 4	N/A	i915 compatibility; RAID 0, 1, 0+1; Gigabit Ethernet; integrated WAP; HD Audio
Q3 2004	SiS R659FX	Pentium 4	800MHz FSB, four 16-bit channels, PC1333 RDRAM support, PCI Express x16 external graphics support (no support for AGP)	N/A
Q4 2004	SiS R659FX	Pentium 4	800MHz FSB, 64-bit memory bus width, DDR2 400/533/667/800 ECC support, PCI Express x16 external graphics support (no support for AGP)	N/A
Q1 2005	SiS R659TX	Pentium 4	800MHz FSB, four 16-bit channels, PC1600 RDRAM support, PCI Express x16 external graphics support (no support for AGP)	N/A

GUIDE TO AMD-COMPATIBLE CHIPSETS

SiS' & VIA's New Chipsets Add 64-Bit Support

Since the last issue, there have been only a handful of new AMD-compatible processors. SiS has been by far the most active of the AMD-compatible chipset manufacturers. The company introduced three new northbridge chips and three new southbridge chips, providing 64-bit and PCI Express support to AMD systems. In addition, the SiS755FX northbridge added support for a 1,000MHz FSB. In the meantime, VIA introduced the VIA K8T800 Pro, a chipset that provides a new VIA option for manufacturers of 64-bit and dual-processor AMD-based motherboards. VIA also introduced two southbridge chips that let users take advantage of 7.1-channel audio. Although only a few new AMD-compatible chipsets were released in the past few months, users will find that these chipsets add a number of features to AMD-based motherboards.

Compiled by Kylee Dickey



SOURCE: VIA

SiS Northbridge Chips

Northbridge Chips	SiS755FX	SiS756	SiS760
Date Of Introduction	Nov.13, 2003	March 18	March 11
Compatible AMD Processors	AMD Athlon 64FX, AMD Athlon 64, AMD Opteron	AMD Athlon 64FX, AMD Athlon 64, AMD Opteron	Athlon 64, Opteron
Number Of Processors	one	one	one
System Bus	1,000MHz	533MHz	800MHz
Supported Memory	up to 3GB through up to three DDR400 DIMMs (dependent upon CPU support)	DDR400/DDR333	dependent upon CPU
Error Correction?	No	No	dependent upon CPU
Integrated Graphics	N/A	No	SiS Mirage 2
External Graphics	AGP8X	PCI Express x16	AGP8X
Northbridge Features	HyperTransport	HyperTransport	HyperStreaming, Opteron support, SiS Mirage 2 integrated graphics
North/Southbridge Link	MuTIOL 1G multithreaded I/O Link (1GBps) to SiS964, SiS965, or SiS965L southbridge	MuTIOL 1G multithreaded I/O Link (1GBps) to SiS965 southbridge	MuTIOL 1G multithreaded I/O Link (1GBps) to SiS964 southbridge

SiS Southbridge Chips

Southbridge Chips	SiS964	SiS965	SiS965L
Date Of Introduction	Nov.13, 2003	Feb. 25, 2004	Jan. 15, 2004
I/O Controller Hub	MuTIOL 1G multithreaded I/O Link (1GBps) to SiS775FX or SiS760 northbridge	MuTIOL 1G multithreaded I/O Link (1GBps) to SiS755 or SiS756 northbridge	MuTIOL 1G multithreaded I/O Link (1GBps) to SiS775FX northbridge
IDE Support	supports ATA133/100/66	supports ATA133/100	supports ATA133/100
SATA	two SATA ports; RAID 0, 1; JBOD	four SATA ports; RAID 0, 1; JBOD	two SATA ports; RAID 0,1; JBOD
USB Ports	eight integrated Hi-Speed USB 2.0 and full-speed USB controllers	eight integrated Hi-Speed USB 2.0 and full-speed USB controllers	supports eight Hi-Speed USB 2.0 ports
Audio	AC'97 5.1-channel	AC'97 2.3 7.1-channel	supports 7.1-channel AC'97 2.3
Network Support	10/100-BaseT	Gigabit Ethernet	10/100-BaseT
Target Market	64-bit systems (when linked with SiS775FX northbridge)	64-bit systems (when linked with SiS775FX northbridge)	Systems with PCI Express
Features	64-bit support, MuTIOL 1G multithreaded I/O Link (1GBps), eight integrated Hi-Speed USB 2.0 and full-speed USB controllers, supports six PCI slots	64-bit support, MuTIOL 1G multithreaded I/O (1GBps), eight integrated Hi-Speed USB 2.0 controllers, support for six PCI2.3 slots, support for two PCI Express x1 slots	PCI Express support, MuTIOL 1G multithreaded I/O Link (1GBps), two SATA ports, RAID 0 and RAID 1, eight Hi-Speed USB 2.0 ports, eight-channel audio

VIA Northbridge Chips

Northbridge Chips	VIA K8T800 Pro	VIA KT880
Date Of Introduction	May 6, 2004	Feb. 12, 2004
Compatible AMD Processors	Athlon 64FX, Athlon 64, Opteron	Athlon XP
Number Of Processors	one or two	one
System Bus	asynchronous	400/333MHz
Supported Memory	up to four DDR400/333/266 DIMMs	up to 8GB of dual-channel DDR400/333 SDRAM
Error Correction?	No	No
Integrated Graphics	N/A	N/A
External Graphics	AGP8X	AGP8X
Northbridge Features	HyperTransport, dual-processor support, 64-bit support	DualStream 64, up to 8GB of DDR
North/Southbridge Link	V-MAP to VIA VT8237 southbridge (released July 2, 2003)	V-Link (533MBps) to VT8237 southbridge (released July 2, 2003)

The Near Future

There are no SiS chipsets on the immediate horizon. The company has already released several Athlon 64 FX-, Athlon 64-, and Opteron-compatible chipsets this year. In the future, you can expect to see only PCI Express x16 support. SiS plans to make the leap to the new technology and leave AGP8X external graphics support behind. See the chart for future VIA chipsets.

	SiS	VIA		
	?	K8T890 (Northbridge)	VT8237CE (Southbridge)	VT8251 (Southbridge)
Estimated Date Of Release	?	Q2-Q3 2004	Q2-Q3 2004	Q2-Q3 2004
Compatible AMD Processors	?	Athlon 64, Athlon 64 FX, Opteron	(depends on which northbridge is coupled with this chip)	(depends on which northbridge is coupled with this chip)
External Graphics	?	PCI Express x16, AGP8X	N/A	N/A
North/Southbridge Link	?	HyperTransport (1GHz)	N/A	N/A
IDE Support	?	N/A	up to four ATA devices	up to four ATA devices
SATA	?	N/A	two SATA ports; RAID 0, 1, 0+1; JBOD	four SATA ports; RAID 0, 1, 0+1; JBOD
USB Ports	?	N/A	eight Hi-Speed USB 2.0 ports	eight Hi-Speed USB 2.0 ports
Audio	?	N/A	six-channel AC'97	eight-channel 192KHz/24-bit; six-channel AC'97
Network Support	?	N/A	10/100-BaseT	10/100; possible Gigabit Ethernet
Features	?	PCI Express x16, AGP8X, HyperTransport (1GHz)	RAID configurations	two PCI Express 1x ports

Compiled by
Andrew Leibman & Eric Reed

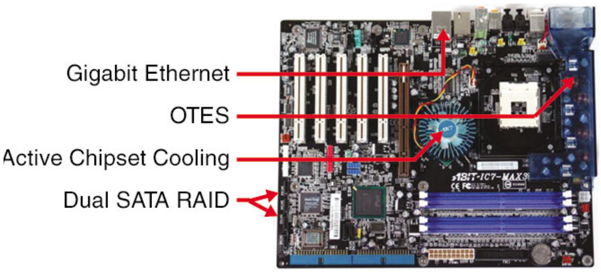
MAINBOARD MAYHEM

17 Motherboard Manufacturers Bring Us 34 Of Their Most Popular & Feature-Rich Motherboards

ABIT IC7-MAX 3

Little has changed in the past year for ABIT, as the IC7-MAX 3 still holds the top spot for Intel chips. The actively cooled i875P chipset works to take full advantage of Hyper-Threading-enabled Pentium 4s by prioritizing the incoming multiple threads. The 800MHz FSB coupled with Intel's PAT (Performance Acceleration Technology) and dual-channel DDR400 memory make a powerful statement about this board's staying power. The IC7-MAX 3 has an upper capacity of 4GB of either DDR400 or DDR333 memory.

ABIT's unique OTES (Outside Thermal Exhaust System) delivers a breath of fresh air to the heat-prone VRM (Voltage Regulator Module) and gives enthusiasts one less heat-producing element to worry about. Another notable feature of the IC7-MAX 3 is the multitude of SATA ports. With six ports, the IC7-MAX 3 offers RAID 0, 1, and 0+1 functionality for added data security. Six channels of integrated audio has become an almost standard feature. The IC7-MAX 3 features one-click BIOS Flash, which is one of the most advanced ways to update the BIOS through Windows. ABIT's SecureIDE encrypts your data to keep it safe from hackers and other would-be data thieves. ▲

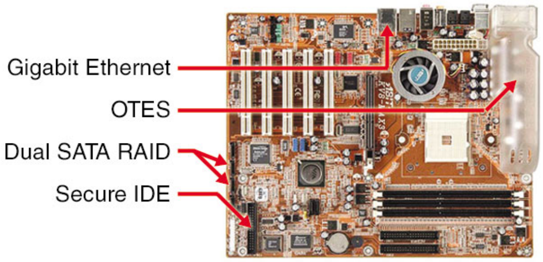


ABIT IC7-MAX 3	
Socket Type	Socket 478 Intel
Chipset	Intel 875P, ICH5
Processor Support	P4 with Hyper-Threading (800/533MHz FSB)
RAM Support	4GB DDR400/333
RAM Slots	4
Graphics Bus	AGP 8X
PCI Slots	5
SATA Ports	6 (ICH5; RAID 0, 1; Silicon Image; RAID 0, 1, 0+1)
IDE	ATA/100
USB Ports	6 (2.0)
FireWire Ports	3 (FireWire 400)
LAN	Intel Gigabit
Integrated Audio	6-channel, AC'97, SPDIF
Integrated Graphics	N/A
Other Features	OTES, Secure IDE
Manufacturer	ABIT
Phone	(510) 623-0500
URL	www.abit-usa.com
Price	$182

ABIT KV8-MAX 3

ABIT's enthusiast board for AMD is the KV8-MAX 3, which has remained the most popular of ABIT's AMD boards since September 2003. The 754-pin socket supports the Athlon 64 processor rather than the Athlon 64 FX or Opteron. With the 64-bit capability and an 800MHz FSB, it's no wonder this board is showing strong despite Windows XP 64-bit Edition's delay. With 2GB of DDR400, DDR333, or DDR266, this board may not seem as expandable as those on the Intel side, but 64-bit chips allow the memory addressing for up to 16GB, so look for the memory capacities to jump.

The KV8-MAX 3 also features the OTES system to cool those heat-producing voltage regulators. ABIT has equipped the KV8-MAX 3 with µGuru, which is an integrated hardware chip that allows system monitoring without taking a performance hit. OC Guru is a Windows-based overclocking utility that lets a user make adjustments without having to reboot. ABIT's top AMD board also offers ATA/133 to the IC7-MAX 3's ATA/100. With SATA ports aplenty, the KV8-MAX 3 allows RAID 0, 1, and 0+1. The board also features six channels of integrated audio and SPDIF input/output ports. ▲



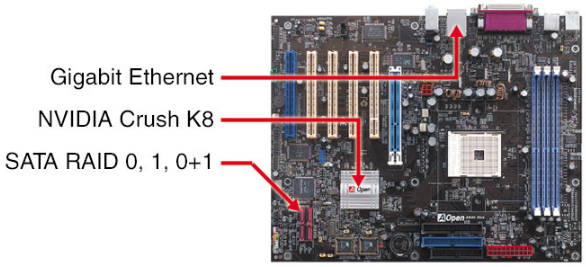
ABIT KV8-MAX 3	
Socket Type	Socket 754 AMD
Chipset	VIA K8T800, VT8237
Processor Support	Athlon 64 (800MHz FSB)
RAM Support	2GB DDR400/ 333/266, ECC
RAM Slots	3
Graphics Bus	AGP 8X
PCI Slots	5
SATA Ports	6 (VT8237; Silicon Image; RAID 0, 1, 0+1)
IDE	ATA/133
USB Ports	6 (2.0)
FireWire Ports	3 (FireWire 400)
LAN	Gigabit
Integrated Audio	6-channel, AC'97, SPDIF
Integrated Graphics	N/A
Other Features	OTES, Secure IDE
Manufacturer	ABIT
Phone	(510) 623-0500
URL	www.abit-usa.com
Price	$140

AOPEN AK89 MAX

The 754-pin Athlon 64 processor finds a comfortable place in AOpen's AK89 MAX, and with an upper limit of 3GB of DDR400 memory, the AK89 MAX is a powerful place indeed. The AK89 MAX also sports the NVIDIA Crush K8 chipset and an 800MHz FSB. You won't be lacking peripheral connectivity with this board; the AK89 MAX offers six USB 2.0 ports, as well as three FireWire 400 ports.

EZ Clock is a Windows-based interface that lets users set the voltage and frequency values of the CPU, AGP, PCI, frontside bus, and memory. EZ Clock synchronizes the values for all adjusted components; however, you can still adjust your components independently from the BIOS.

The Ultra ATA-133 interface technology offers nice speeds from any of the four SATA ports to your drives. The Silicon Image Serial ATA controller allows for the high-speed data accessibility of RAID 0, as well as the foolproof data security of RAID 1, and the best of both worlds in RAID 0+1. As an additional benefit, the RAID controller enables level 5 RAID, especially important for those of you who absolutely cannot afford downtime during a LAN party. The AK89 MAX also features integrated 6-channel Realtek AC'97 audio and SPDIF input/output ports. ▲



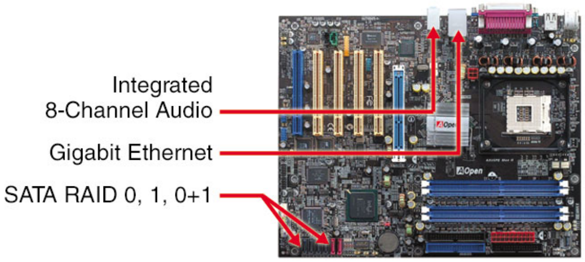
AOpen AK89 MAX	
Socket Type	Socket 754 AMD
Chipset	NVIDIA Crush K8
Processor Support	Athlon 64 (800MHz FSB)
RAM Support	3GB DDR400
RAM Slots	3
Graphics Bus	AGP 8X
PCI Slots	5
SATA Ports	4 (RAID 0, 1, 0+1, 5)
IDE	ATA/133
USB Ports	6 (2.0)
FireWire Ports	3 (Agere FireWire 400)
LAN	Realtek Gigabit
Integrated Audio	5.1-channel Realtek, SPDIF
Integrated Graphics	N/A
Other Features	EZRestore, EZClock, SilentTek
Manufacturer	AOpen
Phone	(888) 972-6736
URL	usa.aopen.com
Price	$117

AOPEN AX4SPE MAX II

AOpen's enthusiast motherboard for Intel processors is the AX4SPE MAX II, but the spokesperson we talked to mentioned that the i915/i925 chipset boards will probably assume that role in the near future. Until then, this 865PE and ICH5 board delivers up to 4GB maximum DDR400 memory and an 800MHz FSB, which is plenty to take advantage of Intel's latest Pentium 4 with Hyper-Threading.

Most users would find it difficult to fill all 10 peripheral ports (eight USB 2.0 and two FireWire 400). Eight channels of integrated audio is a laudable step above many of the motherboards in this sampler, and gaming enthusiasts are sure to impress with 7.1 surround sound.

The AX4SPE MAX II supplies users with six SATA ports and the integrated Silicon Image controller enables RAID 0, 1, and 0+1. ATA speeds peak at 100MBps for this motherboard, as opposed to the 133MBps ATA interface that the AK89 MAX enjoys. Also included is the EZ Clock graphical overclocking interface. The AX4SPE MAX II also features the SilentTek interface, which lets you control the noise output of your system based on your immediate computing needs via Hardware-Status Monitoring, Overheat Warning, and Fan Speed Control. ▲



AOpen AX4SPE MAX II	
Socket Type	Socket 478 Intel
Chipset	Intel 865PE, ICH5
Processor Support	P4 with Hyper-Threading (800/533/400MHz FSB)
RAM Support	4GB DDR400
RAM Slots	4
Graphics Bus	AGP 8X
PCI Slots	5
SATA Ports	6 (ICH5; RAID 0, 1; Silicon Image; RAID 0, 1, 0+1)
IDE	ATA/100
USB Ports	8 (2.0)
FireWire Ports	2 (Agere FireWire 400)
LAN	Intel Gigabit
Integrated Audio	8-channel, Realtek AC'97
Integrated Graphics	N/A
Other Features	EZClock, SilentTek
Manufacturer	AOpen
Phone	(888) 972-6736
URL	usa.aopen.com
Price	$139

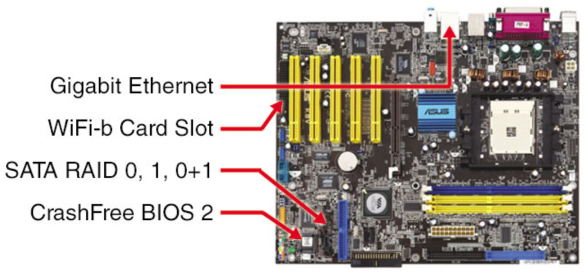
ASUS K8V SE DELUXE

The hot motherboard from ASUS for the Athlon 64 processor is the K8V SE Deluxe. This 754-pin board is built with VIA's K8T800 and VT8237 chipset, and it supports a frontside bus frequency of 800MHz. You can install as much as 3GB of ECC or non-ECC memory in DDR400, DDR333, or DDR266 variations.

ASUS has also included a Wi-Fi slot in case you want to migrate to a wireless LAN. This updated KV8 board offers one more FireWire 400 port from the previous version, for a total of two. In addition, the eight USB 2.0 ports should keep just about everything you own plugged and playable.

The Promise R20378 RAID controller supports RAID 0, 1, and 0+1 configurations on the four provided SATA ports. Integrated ADI AD1980 6-channel audio is standard and includes SPDIF input/output ports. ASUS' CPR (CPU Parameter Recall) feature will reset your parameters to their default settings in case your system fails to boot. CrashFree BIOS 2 provides a bootable CD that walks you through the autorecovery of your BIOS should your system crash. The K8V SE Deluxe also comes with Trend Micro PC-cillin 2002 antivirus software (OEM version). ▲

ASUS K8V SE Deluxe	
Socket Type	Socket 754 AMD
Chipset	VIA K8T800, VT8237
Processor Support	Athlon 64 (800MHz FSB)
RAM Support	3GB DDR400/333/266
RAM Slots	3
Graphics Bus	AGP 8X
PCI Slots	5
SATA Ports	4 (RAID 0, 1, 0+1)
IDE	ATA/133
USB Ports	8 (2.0)
FireWire Ports	2 (FireWire 400)
LAN	Marvell 88E8001 Gigabit
Integrated Audio	6-channel, ADI AD1980, SPDIF
Integrated Graphics	N/A
Other Features	CrashFree BIOS2, CPU Parameter Recall
Manufacturer	ASUS
Phone	(502) 995-0883
URL	usa.asus.com
Price	$123



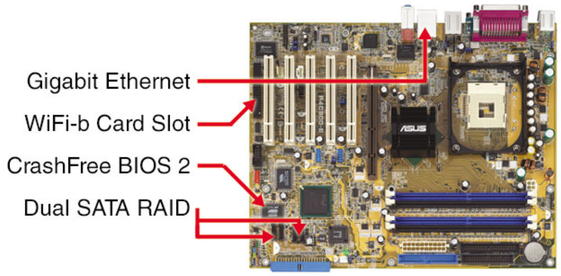
ASUS P4C800-E DELUXE

On the Intel side of ASUS' coin, we have the P4C800-E Deluxe, which is ASUS' most popular mainboard for socket 478 Pentium 4 processors with Hyper-Threading. The 875P MCH and ICH5R chipset delivers 800MHz of FSB speed and can handle a generous maximum of 4GB of DDR400, DDR333, or DDR266 memory. With DDR400 memory, the P4C800-E Deluxe utilizes Intel's PAT (Performance Acceleration Technology) to speed up the data path between the CPU and system memory, which can yield performance gains of between 3% and 5%.

The Promise SATA controller built into the P4C800-E Deluxe delivers Multi-RAID Function, which lets users implement RAID with the two Ultra ATA/133 ports and an additional array with the two SATA ports. Peripherals connect to the P4C800-E Deluxe via eight USB 2.0 ports and one FireWire 400 port.

The P4C800-E Deluxe features ASUS AI. The 6-channel AI AUDIO can tell you if you have peripherals incorrectly connected to the line-in, line-out, and microphone ports. AI BIOS features CrashFree BIOS2; Q-Fan, which adjusts fan speeds based on system need; and ASUS POST reporter, which features a voice rather than beep codes or blinking LEDs to notify you of any system errors. AI Overclocking lets users adjust system settings with a graphical interface, while automatically synchronizing settings to help ensure a stable session. ▲

ASUS P4C800-E Deluxe	
Socket Type	Socket 478 Intel
Chipset	Intel 875P MCH, ICH5R
Processor Support	P4 with Hyper-Threading (800/533/400MHz FSB)
RAM Support	4GB DDR400/333/266
RAM Slots	4
Graphics Bus	AGP 8X
PCI Slots	5
SATA Ports	4 (RAID 0,1; RAID 0, 1, 0+1, multiple RAID)
IDE	Ultra DMA/100/133 (Promise 20378 RAID 0, 1, 0+1)
USB Ports	8 (2.0)
FireWire Ports	1 (FireWire 400)
LAN	Intel Gigabit
Integrated Audio	6-channel, ADI AD1985 Sound MAX, SPDIF
Integrated Graphics	N/A
Other Features	CrashFree BIOS2, CPU Parameter Recall
Manufacturer	ASUS
Phone	(502) 995-0883
URL	usa.asus.com
Price	$179

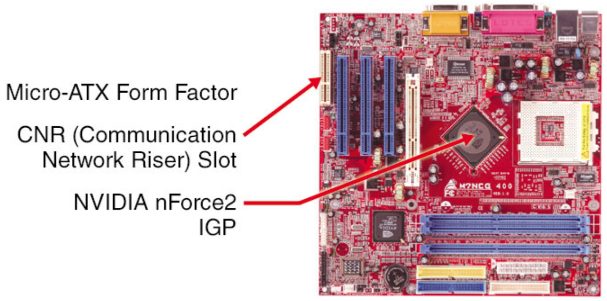


BIOSTAR M7NCG 400

Biostar offers the M7NCG 400 as its best AMD mainboard based on affordability and overclockability. This MicroATX motherboard is compatible with Socket A AMD chips such as the Athlon XP, Athlon, and Duron. The M7NCG 400 features the nForce2 IGP, MCP chipset, which supports a 400MHz frontside bus. The three memory slots are capable of up to 3GB of DDR333, DDR266, or DDR200 memory.

The MicroATX form factor does have drawbacks. For instance, you're limited to three PCI slots, but then again the six USB 2.0 ports seem to argue that PCI is overrated. The integrated NVIDIA Ge-Force4 MX GPU also negates the need for extra slots. The Realtek ALC650/655 delivers six channels of audio. FireWire fans look elsewhere: The M7NCG 400 doesn't support IEEE 1394.

The M7NCG 400 features WarpSpeeder, which is a control panel that lets users monitor their hardware configurations with Hardware Manager, adjust CPU frequencies with Overclock Manager, and adjust CPU core and memory voltages with Overvoltage Manager. For the enthusiast on a shoestring budget, the M7NCG 400, which costs about half as much as the midpriced motherboards in this roundup, is proof that big things can come in small packages. ▲



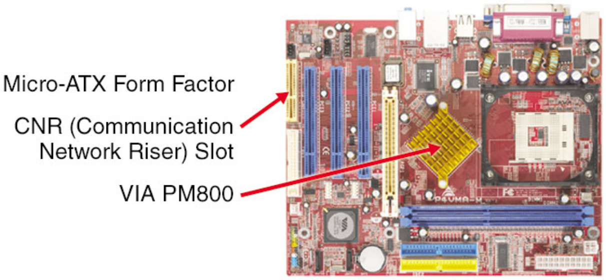
Biostar M7NCG 400	
Socket Type	Socket A 462 AMD
Chipset	nForce2 IGP, MCP
Processor Support	Athlon/Athlon XP/Duron (400/333/266MHz FSB)
RAM Support	3GB DDR333/266/200
RAM Slots	3
Graphics Bus	AGP 8X
PCI Slots	3
SATA Ports	N/A
IDE	Ultra DMA/133
USB Ports	6 (2.0)
FireWire Ports	N/A
LAN	MCP NVIDIA MAC, Realtek RTL8201BL PHY
Integrated Audio	6-channel, AC'97, Realtek ALC650/655
Integrated Graphics	GeForce4 MX GPU
Other Features	Overclock Manager, Overvoltage Manager, Hardware Monitor
Manufacturer	Biostar
Phone	886-2-2218-0150 (Taiwan)
URL	www.biostar.com.tw
Price	$64

BIOSTAR P4VMA-M V7.X

The P4VMA-M is another MicroATX board from Biostar ideal for overclockers on a budget. The 478 socket can handle a Northwood/Prescott Celeron or Pentium 4 processor with Hyper-Threading. The P4VMA-M offers up to 800MHz FSB speeds and features VIA's PM800 and VT8237 chipset to control the speedy flow of information. The P4VMA-M is a little short on the memory side, as it only features two slots for a maximum of 2GB of DDR400 memory. Biostar is banking on the idea that users interested in the smaller form factor are willing to make the sacrifice of a few PCI and memory slots.

Storage isn't a problem with two SATA ports and room for up to four IDE drives. Up to eight USB 2.0 ports are available to connect your peripherals, but Biostar has excluded FireWire support. Six channels of integrated audio are available courtesy of an integrated AC'97 2.3 codec. The integrated S3 UniChrome Pro delivers graphics, but the AGP slot offers the opportunity to upgrade.

Biostar has loaded this small boat with plenty of added features to keep it floating. The hardware monitoring features let you keep track of CPU temperature and system voltage and adjust CPU and system fan speeds. WarpSpeeder lets you fiddle with your settings with the aid of a graphical interface. ▲



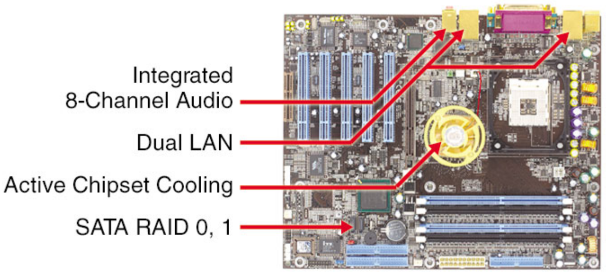
Biostar P4VMA-M V7.x	
Socket Type	Socket 478 Intel
Chipset	VIA PM800, VT8237
Processor Support	P4 with Hyper-Threading, Celeron (800/533MHz)
RAM Support	2GB DDR400
RAM Slots	2
Graphics Bus	AGP 8X
PCI Slots	3
SATA Ports	2
IDE	Ultra DMA/133
USB Ports	8 (2.0)
FireWire Ports	N/A
LAN	VIA VT6103 10/100
Integrated Audio	6-channel, AC'97 2.3
Integrated Graphics	S3 UniChrome Pro
Other Features	Overclock Manager, Overvoltage Manager, Hardware Monitor
Manufacturer	Biostar
Phone	886-2-2218-0150 (Taiwan)
URL	www.biostar.com.tw
Price	$58

CHAINTECH 9CJS ZENITH

The 9CJS ZENITH is your best bet for a powerhouse Intel-based mainboard from Chaintech. The socket 478 board supports Celeron or Pentium 4 processors with Hyper-Threading and up to 800MHz FSB speeds. The i875P, ICH5R chipset directs traffic over the black PCB of the 9CJS ZENITH. Intel's PAT enhances the DDR400 memory for a 3% to 5% performance gain, and you can fill the four available slots with a maximum of 4GB.

Peripherals have plenty of room to find a permanent connection, with as many as eight USB 2.0 ports and one FireWire 400 port. The 9CJS ZENITH features two LAN ports from Intel and Realtek. The integrated audio offers eight channels of auditory bliss. This mainboard includes two SATA ports and offers RAID 0 and 1 with the ICH5R controller.

Chaintech bundles APOGEE's Overclocking suite with this motherboard, as well as WinDVD software. The ZENITH series also has several optional accessories designed with the enthusiast in mind. The CBOX3 displays CPU temperatures, reads a bevy of memory cards, and works with the Handigator, a remote control that offers mouse, hotkey, and browser functions. The board features the proprietary CMR (Chaintech Multimedia Riser), which attaches to the CMC (Chaintech Multimedia Card) to deliver two additional FireWire ports, three Audio 7.1-channel surround ports, and one SPDIF port. ▲



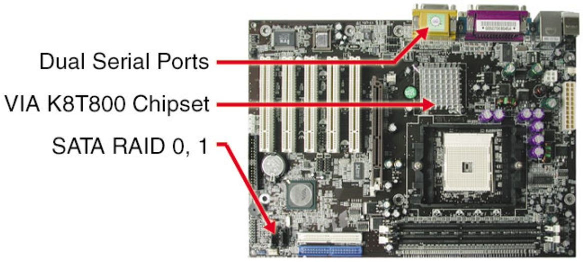
Chaintech 9CJS Zenith	
Socket Type	Socket 478 Intel
Chipset	Intel 875P, ICH5R
Processor Support	P4 with Hyper-Threading, Celeron (800MHz FSB)
RAM Support	4GB DDR400/333/266, ECC/Non-ECC
RAM Slots	4
Graphics Bus	AGP 8X
PCI Slots	5 (v 2.2)
SATA Ports	2 (ICH5R; RAID 0, 1)
IDE	ATA/100
USB Ports	8 (2.0/1.1)
FireWire Ports	1 (VIA VT6306, FireWire 400)
LAN	Intel PRO/1000CT Gigabit, Realtek RTL8101L 10/100Mbps
Integrated Audio	7.1-channel, SPDIF
Integrated Graphics	N/A
Other Features	PAT
Manufacturer	Chaintech
Phone	+886-2-2268-9998 (Taiwan)
URL	www.chaintechusa.com/tw/eng/
Price	$169

CHAINTECH SK8T800

The Athlon 64 feels right at home in the SK8T800 from Chaintech, which is named after the capable VIA K8T800 chipset. This board also supports AMD's Hyper-Transport bus and up to 800MHz FSB speeds. HyperTransport is a dual, unidirectional, chip-to-chip link and is capable of up to 6.4GBps transfer speeds. As much as 2GB of DDR400, DDR333, or DDR266 memory can fill the two available memory slots.

The VIA VT8237 controller manages the USB 2.0 interface for all eight ports, two Ultra DMA/133 IDE ports, and two SATA devices, which support RAID 0 and 1 to keep your data solid and secure. You won't find any FireWire ports on the SK8T800, but for the price this is understandable. Integrated 6-channel audio is courtesy of the AC'97 codec. An SPDIF port is also included.

The external VIA VT6103 PHY supplies Fast Ethernet to the SK8T800. The Boot-Block Flash ROM BIOS has an update available for download from the Chaintech Web site, which solves a few peripheral problems that occur under the original version of the BIOS. This is one of the more affordable mainboards. While not overloaded with extras, the black-and-beige motherboard has enough features to keep enthusiasts happy. ▲



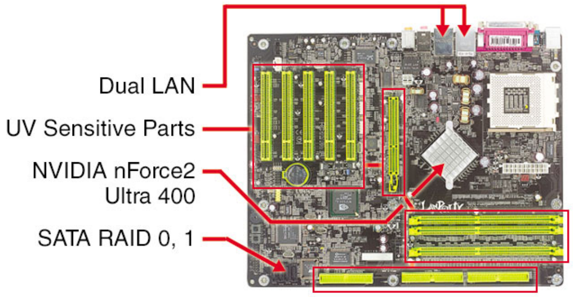
Chaintech SK8T800	
Socket Type	Socket 754 AMD
Chipset	VIA K8T800, VT8237
Processor Support	Athlon 64 (800MHz FSB)
RAM Support	2GB DDR400/333/266
RAM Slots	2
Graphics Bus	AGP 8X
PCI Slots	5 (v2.2)
SATA Ports	2 (RAID 0, 1)
IDE	ATA/133
USB Ports	8 (2.0)
FireWire Ports	N/A
LAN	VIA VT6103 10/100
Integrated Audio	6-channel, AC'97, SPDIF
Integrated Graphics	N/A
Other Features	Two 9-pin male serial ports
Manufacturer	Chaintech
Phone	+886-2-2268-9998 (Taiwan)
URL	www.chaintechusa.com/tw/eng/
Price	$76

DFI LANParty NFII Ultra B

This Socket A motherboard supports FSB speeds of up to 400MHz with the Athlon XP processor or up to 266MHz for Athlon and Duron processors. The NVIDIA nForce2 chipset efficiently delivers information across the board. Three SDRAM sockets offer capacities of up to 3GB, with DDR400, DDR333, DDR266, or DDR200 memory. The neon yellow PCI and memory sockets, which are UV reactive, look particularly striking against the black PCB.

The Silicon Image Sil3114 PCI-to-Serial ATA controller manages the four SATA ports and delivers RAID 0 and 1 functionality. The nForce2 MCP-T and Agere FW803 PHY chips support three FireWire 400 ports and as many as six USB 2.0 ports. The Realtek ALC650 supplies six channels of integrated audio and supports Microsoft DirectSound and DirectSound 3D. Dual LAN is courtesy of the Realtek RTL8110S Gigabit and the nForce2 Agere 10/100 ports.

DFI's LANParty NFII Ultra B offers several additional benefits, including monitors for voltages and your CPU and system temperatures. You can also monitor fan speeds and CPU temps during the boot process. CMOS Reloaded lets overclockers save stable system settings during an overclocking session and recover previous OC settings without restarting from the default BIOS. ▲



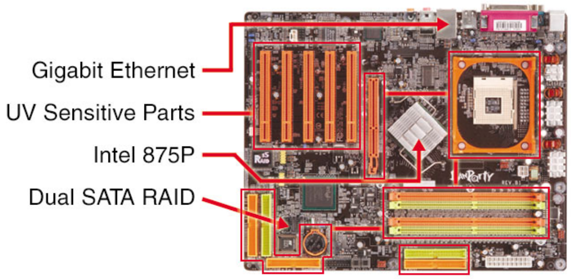
DFI LANParty NFII Ultra B	
Socket Type	Socket A 462 AMD
Chipset	nForce2 Ultra 400, MCP-T
Processor Support	Athlon XP (400/333/266MHz FSB), Athlon, Duron
RAM Support	3GB DDR400/ 333/266/200
RAM Slots	3
Graphics Bus	AGP 8X
PCI Slots	5
SATA Ports	4 (Sil3114; RAID 0, 1)
IDE	ATA/133
USB Ports	6 (2.0/1.1)
FireWire Ports	3 (FireWire 400)
LAN	Realtek RTL8110S Gigabit, nForce2/ Agere 10/100
Integrated Audio	6-channel, SPDIF
Integrated Graphics	N/A
Other Features	CMOS Reloaded, UV Sensitive Parts
Manufacturer	DFI
Phone	(510) 274-8000
URL	www.dfi.com.tw
Price	$142

DFI LANParty PRO875B (rev B)

This 478-socket motherboard is truly for the enthusiast. Pentium 4 with Hyper-Threading and Extreme Edition processors have upper FSB speeds of 800MHz, while the FSB for the Celeron and Pentium 4 Northwood processors top off at 400MHz and 533MHz, respectively. The i82875P memory controller and i82801ER ICH5R chipset deftly manage the flow of information on the PRO875B. Four SDRAM sockets support as much as 4GB of memory at DDR400, DDR333, and DDR266.

The HighPoint 372N RAID controller supports RAID 0, 1, 0+1, and RAID 1.5, while the ICH5R controller provides RAID 0 and 1. The board is capable of having eight USB 2.0 ports, though it lacks any FireWire support. The 82547EI with full-duplex support at 10, 100, and 1000Mbps puts the LAN in LANParty. Integrated audio delivers six channels with SPDIF input/output ports.

Like the AMD LANParty model, the PRO875B features built-in monitors to help users keep track of CPU and system temperatures, as well as system voltages. The board also features automatic chip and second fans on/off control. You can also monitor the fan speeds and temperatures during the crucial bootup process. The brightly colored PCI and memory sockets are also UV sensitive, so users with windowed PCs may want to shed some black light on this board. ▲



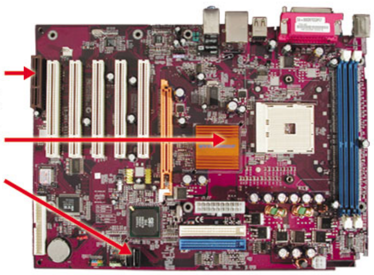
DFI LANParty PRO875B (rev B)	
Socket Type	Socket 478 Intel
Chipset	Intel 875P, ICH5R
Processor Support	P4 Extreme Edition, P4 with Hyper-Threading, Celeron (800/ 533MHz FSB)
RAM Support	4GB DDR400/333/ 266, ECC/Non-ECC
RAM Slots	4
Graphics Bus	AGP 8X
PCI Slots	5 (2.2)
SATA Ports	2 (ICH5R; RAID 0, 1)
IDE	ATA/100 (High-Point 372N RAID 0, 1, 0+1, 1.5)
USB Ports	8 (2.0/1.1)
FireWire Ports	N/A
LAN	82547EI Gigabit
Integrated Audio	6-channel, SPDIF
Integrated Graphics	N/A
Other Features	CMOS Reloaded, UV Sensitive Parts
Manufacturer	DFI
Phone	(510) 274-8000
URL	www.dfi.com.tw
Price	$174

ECS 755-A2

ECS, also known as Elitegroup, brings us the Athlon 64-based 755-A2, which supports AMD's HyperTransport bus technology. This socket 754 board supports as much as 1600 mega-transfers per second over AMD's HyperTransport links and a maximum of 2GB of DDR400, which enables up to 3.4GBps of bandwidth. The 755-A2 also supports DDR333, DDR266, or DDR200 memory. The SiS 755 chip powers the northbridge, and the SiS964 chip powers the southbridge of the 755-A2.

The southbridge SiS964 chip controls two SATA devices at RAID 0 and 1 configurations, as well as four Ultra DMA devices at 133, 100, or 66MBps. This board features a plethora of USB 2.0 ports and headers, which let you connect up to eight devices. However, FireWire support is absent. LAN comes courtesy of the Realtek RTL820BL. The 755-A2's integrated Realtek ALC655 provides six channels of AC'97 2.3-compliant audio. An SPDIF out header is also included on this motherboard.

The 755-A2 also features an Award BIOS with 2Mb Flash ROM, which supports Plug and Play 1.0A, APM 1.2, Multi Boot, DMI, and the ACPI revision 1.0 specification. Elitegroup threw in the 2002 edition of Trend Micro's PC-cillin antivirus software. ▲

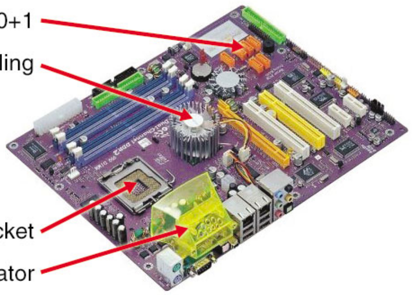


ECS 755-A2	
Socket Type	Socket 754 AMD
Chipset	SiS 755, 964
Processor Support	Athlon 64 (1600/1200/800/400 mega-transfers per second)
RAM Support	2GB DDR400/333/266/200
RAM Slots	2
Graphics Bus	AGP 8X
PCI Slots	5
SATA Ports	2 (RAID 0, 1)
IDE	Ultra DMA/133/100/66
USB Ports	8 (2.0)
FireWire Ports	N/A
LAN	Realtek RTL820BL 10/100
Integrated Audio	6-channel, Realtek ALC655, SPDIF
Integrated Graphics	N/A
Other Features	WinFlash Utility, PC-cillin 2002
Manufacturer	ECS (Elitegroup)
Phone	(510) 226-7333
URL	www.ecsusa.com
Price	$88

ECS PF4 EXTREME

They don't call this motherboard Extreme for nothin'. The latest and greatest from ECS is the first (and only) mainboard in this roundup to feature Intel's new 915P and ICH6 chipset. This board's LGA775 Socket T, for Prescott Pentium 4 processors, features the pins on the motherboard rather than on the CPU. FSB speeds for the PF4 are 800 and 533MHz. The PF4 also supports dual-channel DDR2 memory, with speeds topping out at 533MHz. Up to 4GB of memory can fill the four 240-pin DIMM sockets.

ECS is taking another bold step with the PF4 by reducing the number of PCI slots to three to make room for two PCI Express slots. Even the AGP slot has been replaced with what ECS calls an AGP Express slot. The Marvell 88E8001 Gigabit controller and Realtek RTL8100C Fast Ethernet controller provide the PF4's dual LAN. The Cooling Accelerator is a vented fan and heatsink assembly, similar to Abit's OTES, which cools the PWM (pulse width modulator) controller. This board also offers up to eight USB ports and two FireWire ports. Eight-channel integrated audio comes from the C-Media CMI9880 CODEC, which is compliant with Intel's Azalia specification. The PF4 also includes SPDIF input/outputs. ▲



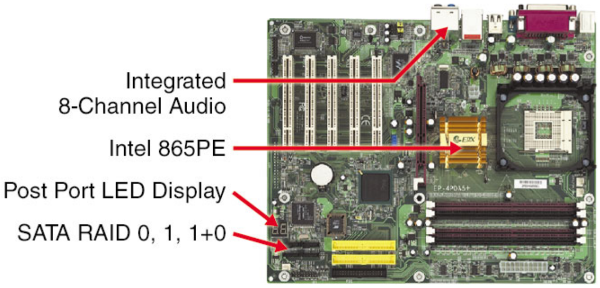
ECS PF4 Extreme	
Socket Type	Socket T LGA 775 Intel
Chipset	Intel 915P, ICH6
Processor Support	Pentium 4, Prescott, with Hyper-Threading (800/533MHz FSB)
RAM Support	4GB DDR533/400
RAM Slots	4 (DDR2 240-pin socket)
Graphics Bus	AGP Express
PCI Slots	3 PCI; 2 PCI Express x1; 1 PCI Express x16
SATA Ports	6 (RAID 0/1/0+1)
IDE	UltraDMA 133/100
USB Ports	8 (2.0)
FireWire Ports	1 (FireWire 400), 1 header
LAN	Marvell Gigabit LAN, Realtek 10/100 Ethernet
Integrated Audio	8-channel, C-Media
Integrated Graphics	N/A
Other Features	Cooling Accelerator
Manufacturer	ECS (Elitegroup)
Phone	(510) 226-7333
URL	www.ecsusa.com
Price	N/A

EPoX EP-4PDA5+

EPoX's popular 478-socket Intel board supports the Pentium 4 Northwood and Prescott processors with a maximum FSB speed of 800MHz. There's even room for Intel's Celeron processor, with FSB speeds of 400MHz. The i865PE chipset powers this motherboard, while the Silicon Image controller provides RAID 0, 1, and 1+0 support to the four SATA ports. The Ultra DMA support is capable of 100MBps and up to four drives. The four memory sockets are capable of a total of 4GB of RAM in DDR400, DDR333, or DDR-266 variations.

The six possible USB 2.0 hubs go solo with nary a FireWire port to speak of. The Marvell 88E8001 provides Gigabit Ethernet connectivity. Realtek ALC850 integrated audio delivers an impressive 8-channel surround sound with SPDIF ports.

EPoX supplied the EP-4PDA5+ with EZ Boot, which lets users select a bootable device by pressing the ESC key rather than having to navigate the BIOS menu. Post Port, another unique feature of this EPoX board, is an integrated LED display that users can troubleshoot from. EPoX's Power BIOS features overclocking functions that let you adjust the FSB, AGP, and memory frequencies, as well as manipulate the voltage settings for your system. ▲



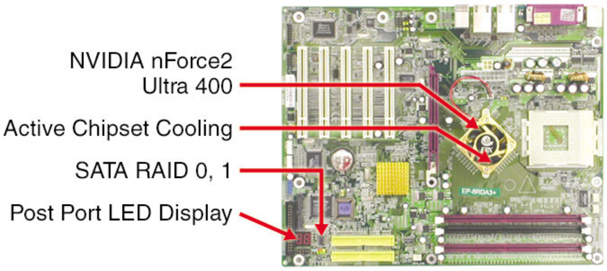
EPoX EP-4PDA5+	
Socket Type	Socket 478 Intel
Chipset	Intel 865PE, ICH4
Processor Support	P4 with Hyper-Threading, Celeron (800/533/400MHz FSB)
RAM Support	4GB DDR400/333/266
RAM Slots	4
Graphics Bus	AGP 8X
PCI Slots	5
SATA Ports	4 (Sil3114, RAID 0, 1, 1+0)
IDE	Ultra DMA/100
USB Ports	6 (2.0)
FireWire Ports	N/A
LAN	Marvell 88E8001 Gigabit
Integrated Audio	8-channel, Realtek ALC850, SPDIF
Integrated Graphics	N/A
Other Features	EZ-Boot
Manufacturer	EPoX
Phone	(714) 680-0898
URL	web.epox.com
Price	$105

EPoX EP-8RDA3+

The EP-8RDA3+, a circuit-board green Socket A motherboard, is designed for the Athlon XP, Athlon, and Duron processors. This board supports FSB speeds of 400MHz, 333MHz, 266MHz, and 200MHz. As much as 3GB of DDR400, DDR333, and DDR266 will fit into the three available sockets. The NVIDIA nForce2 Ultra 400 chipset powers the EP-8RDA3+.

Two SATA ports feature RAID 0 and 1 functionality via the Silicon Image Sil3112a controller. The board also delivers two Ultra ATA/133 ports for a maximum of four devices. A total of eight possible USB 2.0 ports accompany three Agere FireWire 400 ports for connecting as many peripherals as you can muster. The Realtek ALC65X provides six channels of integrated audio and an optical and RCA SPDIF out.

The EP-8RDA3+ is bundled with Norton's Ghost software, which lets you make a backup of your important information to protect against data loss. Trend Micro PC-cillin antivirus software is also included, as is EZ Boot and the onboard LED troubleshooting display. EPoX's Power BIOS makes overclocking easy by giving direct access to the multiplier, voltages, and frequencies for the CPU, AGP, and memory. ▲



EPoX EP-8RDA3+	
Socket Type	Socket A 462 AMD
Chipset	nForce2 Ultra 400, MCP
Processor Support	Athlon, Athlon XP, Duron (400/333/266/200MHz FSB)
RAM Support	3GB DDR400/333/266
RAM Slots	3
Graphics Bus	AGP 8X
PCI Slots	5
SATA Ports	2 (Sil3112a; RAID 0, 1)
IDE	ATA/133
USB Ports	8 (2.0)
FireWire Ports	3 (Agere FireWire 400)
LAN	Realtek RTL8201 10/100
Integrated Audio	6-channel, CMI9739, SPDIF
Integrated Graphics	N/A
Other Features	EZ Boot
Manufacturer	EPoX
Phone	(714) 680-0898
URL	web.epox.com
Price	$89

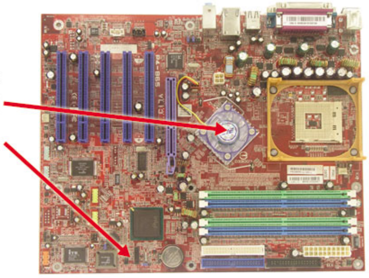
FIC P4-865PE MAX

FIC makes some very colorful boards, and the P4-865PE MAX is no exception. It's pieced together in shades of red, blue, green, and yellow. But more importantly the P4-865PE MAX offers some nice features, as well. It's a socket 478 board with Intel 865PE and ICH5R chipsets. It supports both Pentium 4 and Celeron processors and works with FSB speeds of up to 800MHz. (And thanks to the 865PE chipset, it supports Hyper-Threading technology.) The board also has four dual-channel DIMM sockets for up to 4GB of PC3200/2700/2100 DDR SDRAM.

Both of the board's two SATA ports support RAID 0. If you need lots of extra connections to support your gadgets, it offers ample room, supporting eight USB 2.0 ports and two FireWire ports. It also has five PCI slots. Video expansion is available via an AGP 8X slot.

As for integrated audio, 5.1 AC'97-complaint channels are available through the onboard Realtek ALC650 chip. Ethernet 10/100 connectivity is offered through the board's Realtek RTL 8100 BL chip.

Some of the board's minor extras include auto-power failure recovery, support for keyboard and mouse wakeup, RTC alarm, and Suspend To RAM features. ▲



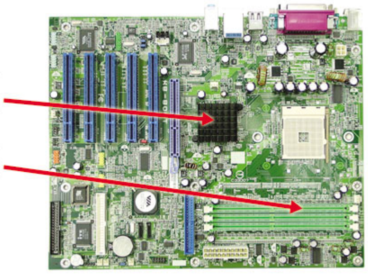
FIC P4-865PE MAX	
Socket Type	Socket 478 Intel
Chipset	Intel 865PE, Intel ICH5R
Processor Support	P4, Celeron (533/800MHz FSB)
RAM Support	4GB DDR400/ 333/266; SPD support
RAM Slots	4
Graphics Bus	AGP 8X
PCI Slots	5
SATA Ports	2 (RAID 0)
IDE	ATA/100/66
USB Ports	8 (2.0)
FireWire Ports	2
LAN	Realtek RTL 8100BL 10/100
Integrated Audio	5.1-channel, AC'97
Integrated Graphics	N/A
Other Features	N/A
Manufacturer	FIC
Phone	(510) 252-7777
URL	www.fic.com.tw
Price	$109

FIC K8-800T

The K8-800T is one of FIC's most popular AMD 64 boards even though it doesn't offer a ton of extra features. Although equipped with VIA's K8T800 northbridge and 8237 southbridge chipsets, the board supports only 2GB of RAM and lacks some of the chipset's potential features, such as Gigabit Ethernet and SATA RAID. Also, even though the board supports 5.1-channel audio (with Realtek ALC655 chip), some other 8237s support VIA Vinyl Gold Audio 7.1 surround sound.

Nevertheless, the K8-800T does have two SATA ports, provides Realtek 8100C LAN connectivity, and has a few other features that are worth noting, such as two FireWire 400 ports and the potential for up to eight USB ports (four front, four in the back). It also offers sufficient expandability, with five PCI slots and an AGP 8X graphics bus.

There's no doubt this would be a better board if FIC had taken full advantage of the K8T800 and 8237 chipsets and offered RAID 0, 1, and 0+1, but the K8-800T is essentially a mainstream value board: It has everything you need to get by, but little in the way of extras. ▲


VIA K8T800 + VIA 8237 Chipset
3 RAM Slots, 2GB DDR400/333/266

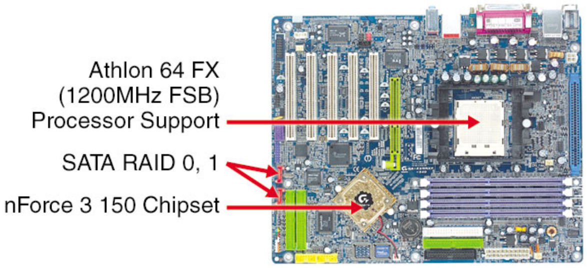
FIC K8-800T	
Socket Type	Socket 754 AMD
Chipset	VIA K8T800, VIA 8237
Processor Support	Athlon 64
RAM Support	2GB DDR400/ 333/266
RAM Slots	3
Graphics Bus	AGP 8X
PCI Slots	5
SATA Ports	2
IDE	ATA/133/100/66
USB Ports	8 (2.0)
FireWire Ports	2
LAN	Realtek 8100C 10/100
Integrated Audio	5.1-channel
Integrated Graphics	N/A
Other Features	N/A
Manufacturer	FIC
Phone	(510) 252-7777
URL	www.fic.com.tw
Price	$159

GIGABYTE GA-K8NNXP-940

If you're looking for an AMD 64 FX board that's loaded with extra features, this board's for you. The GA-K8NNXP-940 is a Socket 940 board, as the name implies, and it works with either an AMD Athlon 64 FX or Opteron 100 processor. It includes plenty of the basics: five PCI slots, four DIMM slots with 3GB of dual-channel DDR400/333/266 registered memory, and four USB 2.0 slots. But it also contains heaps of extras, such as a third Texas Instruments FireWire 800 port, a SPDIF input/output pin header, and CD/AUX input. And even though you probably don't need it, the GA-K8NNXP-940 even contains one DPS (Dual Power System) port.

You also get a 10/100 LAN controller; four ATA/133/100/66 headers supporting RAID 0, 1, 0+1, or JBOD; two SATA ports with support for RAID 0 and 1; and one Game/MIDI connector. Finally, you get AC'97 compatible 6-channel audio from Realtek with an ALC658 chip.

Obviously, the GA-K8NNXP-940 is stacked to the rim with features, but Gigabyte didn't stop there. It also offers system health monitoring and hardware reporting for open case, fan speed, and CPU voltage. ▲



GIGABYTE GA-K8NNXP-940	
Socket Type	Socket 940 AMD
Chipset	NVIDIA nForce3 150
Processor Support	Athlon 64 FX (1200MHz FSB)
RAM Support	3GB Dual DDR400/333/266, registered
RAM Slots	4
Graphics Bus	AGP 8X
PCI Slots	5 (2.3)
SATA Ports	2 (RAID 0, 1)
IDE	ATA/133 (RAID 0, 1, 0+1, JBOD)
USB Ports	4 (2.0)
FireWire Ports	3
LAN	Dual LAN 10/100
Integrated Audio	6-channel, SPDIF (In/Out)
Integrated Graphics	N/A
Other Features	N/A
Manufacturer	GIGABYTE
Phone	(626) 854-9338
URL	www.giga-byte.com
Price	$229

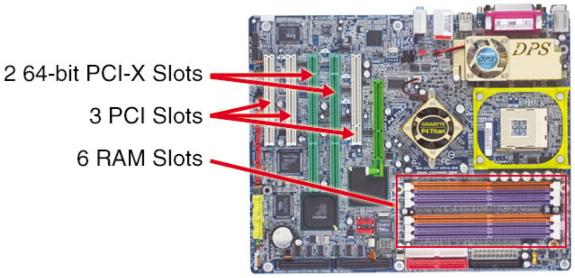
GIGABYTE GA-8KNXP ULTRA-64

On the Intel side, Gigabyte offers the impressive GA-8KNXP Ultra-64, powered by the i875P northbridge and Hance Rapids southbridge. The board's best feature is probably its two 64-bit 66MHz PCI-X slots, which are available through the HR Southbridge and can be used for a Gigabit Ethernet or a SCSI card.

The two chipsets offer a rather extensive list of other features. In addition to an Adaptec Ultra 320 SCSI chip and Intel CSA interface Gigabit Eternet controller, you also get a RAID-supporting Sil3114 chip and a Realtek ALC850 chip with 8-channel audio. (The board also has an SPDIF input, as well as output.)

In addition to offering 800/533/400MHz FSB speeds and 4GB of dual-channel DDR 400/333/266 memory with ECC support, GIGABYTE has affixed a pile of connectors and expansion slots onto the GA-8KNXP Ultra-64. In all, you get six DIMM slots, six SATA ports, two SCSI connectors, an AGP 8X slot, three PCI slots, one DPS (Dual Power System) slot, two ATA ports, one game port pin header, and four USB 2.0 ports.

Lastly, the GA-8KNXP comes with hardware monitoring (such as CPU voltage and fan speed monitoring), and Norton Internet Security 2004. ▲



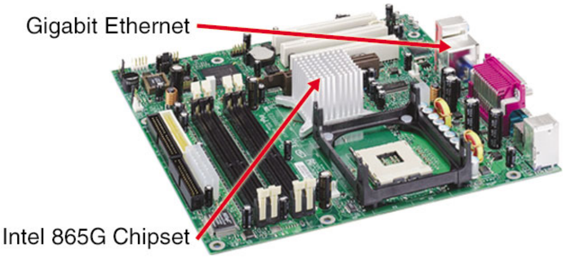
GIGABYTE GA-8KNXP Ultra-64	
Socket Type	Socket 478 Intel
Chipset	Intel 875P MCH, Intel HR(Hance Rapids)
Processor Support	P4 with Intel Hyper-Threading Technology (800/533/400MHz FSB)
RAM Support	4GB Dual DDR400/333/266, ECC
RAM Slots	6
Graphics Bus	AGP 8X
PCI Slots	3
SATA Ports	2
IDE	ATA/100/66
USB Ports	4 (2.0)
FireWire Ports	N/A
LAN	Gigabit LAN 10/100/1000
Integrated Audio	8-channel, SPDIF (In/Out)
Integrated Graphics	N/A
Other Features	Norton Internet Security 2004
Manufacturer	GIGABYTE
Phone	(626) 854-9338
URL	www.giga-byte.com
Price	$355

INTEL D865GRH

This board's specialty is security. Intel touts its TPM (Trust Platform Module), a sort of business-level, hardware-based safety module that provides protection for encryption and digital signature keys, and which runs Wave Systems' EMBASSY Trust Suite software. Ultimately, the TPM is designed to protect against software-based attacks through the computer's hardware.

Even aside from the TPM, however, the D865GRH offers plenty of features that make it a practical choice for most consumers, even those who are less inclined to be concerned about software attacks.

The Socket 478 board is equipped with an 865G chipset and uses 4GB of unbuffered DDR400/333/266 SDRAM (non-ECC) memory in four DIMM slots. Because it lacks FireWire ports and support for RAID technology, the D865GRH is less exciting than some boards. Nevertheless, there are other features worth looking at, including Gigabit LAN 10/100/1000, an AGP 8X slot, eight USB 2.0 ports, three PCI slots, and integrated graphics through an Intel Extreme Graphics 2 controller. SoundMAX 4 XL provides integrated audio and allows for either 2- or 6-channel audio. ▲



INTEL D865GRH	
Socket Type	Socket 478 Intel
Chipset	Intel 865G
Processor Support	P4, Celeron with Hyper-Threading Technology (800/533/400MHz FSB)
RAM Support	4GB DDR400/333/266 SDRAM unbuffered, non-ECC
RAM Slots	4
Graphics Bus	AGP 8X
PCI Slots	3
SATA Ports	2
IDE	ATA/100/66
USB Ports	8 (2.0)
FireWire Ports	N/A
LAN	Gigabit LAN 10/100/1000
Integrated Audio	6-channel, AC'97, SPDIF
Integrated Graphics	Intel Extreme Graphics 2
Other Features	N/A
Manufacturer	Intel
Phone	(800) 538-3373
URL	www.intel.com
Price	N/A

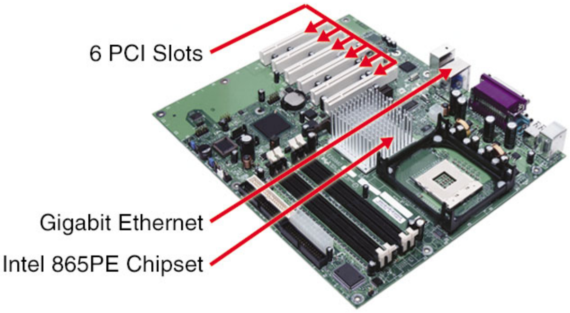
INTEL D865PERC

Even though the D865PERC lacks RAID technology, it still deserves the "next generation" label that Intel affixes to it. Not surprisingly, it supports both Intel P4 and Celeron processors with Hyper-Threading technology at FSB speeds of 800MHz. Like many boards that feature those two processors, however, you can take advantage of the 800MHz speed only with the P4. The maximum FSB speed with a Celeron Processor is 400MHz.

The D865PERC has 4 DIMM slots supporting 4GB of dual-channel DDR400/333/266 unbuffered, non-ECC SDRAM. It is also a Socket 478 board powered by the 865PE chipset.

With six PCI slots and an AGP 8X slot that also supports AGP Digital Display cards, the D865PERC offers plenty of room for expansion. It has eight USB 2.0 ports, two SATA ports, two ATA/100/66 connectors, and Gigabit LAN. Yet another nice feature is the audio: The board provides either two or six channels of AC'97-compatible audio from SoundMAX 4 XL.

Finally, the board features Intel Precision Cooling Technology fan control, which causes the fans to adjust to varying system temperatures, thereby reducing noise, as well as energy consumption. ▲



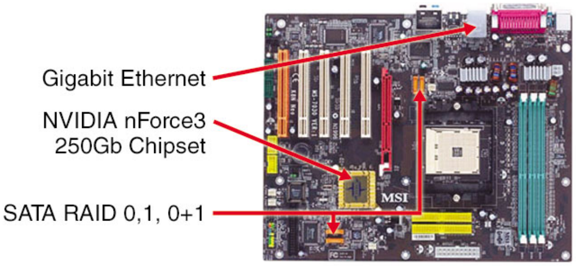
INTEL D865PERC	
Socket Type	Socket 478 Intel
Chipset	865PE
Processor Support	P4, Celeron with Hyper-Threading Technology (800/533/400MHz FSB)
RAM Support	4GB Dual DDR400/333/266 SDRAM, unbuffered, non-ECC
RAM Slots	4
Graphics Bus	AGP 8X
PCI Slots	6
SATA Ports	2
IDE	ATA/100/66
USB Ports	8
FireWire Ports	N/A
LAN	Gigabit LAN 10/100/1000
Integrated Audio	6-channel, AC'97, SPDIF
Integrated Graphics	N/A
Other Features	N/A
Manufacturer	Intel
Phone	(800) 538-3373
URL	www.intel.com
Price	N/A

MSI K8N NEO PLATINUM

An Athlon 64 board with an NVIDIA nForce 3 250Gb chipset, the K8N NEO PLATNUM is a first-rate board and one that is rich in features. The nForce3 250Gb chipset supports an 800MHz HyperTransport interface and has integrated Gigabit LAN (through an NVIDIA nForce3 NV Gigabit LAN controller). It offers eight channels of 7.1 audio with AC'97 2.3 compliance. Moreover, there are also three Firewire ports, support for eight USB ports, five PCI slots, dual ATA /133/100/66/33 with support for up to four IDE devices, an AGP 8X slot, and four SATA ports supporting RAID (0,1, 0+1). The board even features NVIDIA Firewall Technology for online security.

What's more, the K8N NEO PLATINUM is poised for overclocking. Enthusiasts will get a kick out of the board's D.O.T. (Dynamic Overclocking Technology). This is MSI's automatic overclocking feature, which automatically speeds up the CPU in times of extreme performance needs but will then restore your system to default settings whenever the CPU is in a low-load balance.

On the downside, the K8N NEO PLATNUM offers just three DIMM slots that accept only 2GB of non-ECC DDR 400/333/266 single-channel memory. ▲



MSI K8N NEO PLATINUM	
Socket Type	Socket 754 AMD
Chipset	NVIDIA nForce3 250Gb
Processor Support	Athlon 64 (800MHz)
RAM Support	2GB DDR400/333/266, unbuffered, ECC, non-ECC
RAM Slots	3
Graphics Bus	AGP 8X
PCI Slots	5
SATA Ports	4 (RAID 0,1, 0+1)
IDE	ATA/133/100/66
USB Ports	8 (2.0)
FireWire Ports	3
LAN	Gigabit LAN 10/100/1000
Integrated Audio	8-channel, SPDIF (Out)
ntegrated Graphics	N/A
Other Features	nVIDIAFirewall Technology
Manufacturer	MSI
Phone	(626) 913-0828
URL	www.msicomputer.com
Price	N/A

MSI 875PNEO-FISR

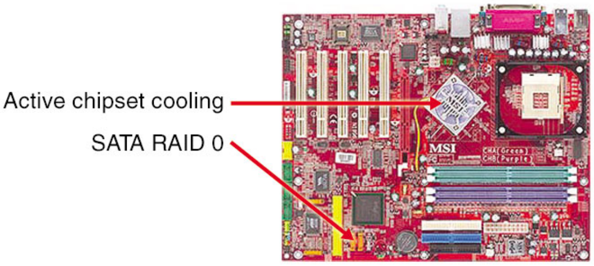
One of MSI's newest boards is the 875PNEO-FISR, an Intel Canterwood 875P and ICH5R board supporting a 3.2GHz Intel P4 processor (Northwood/Prescott/Extreme Edition) and FSB speeds of up to 800/500MHz. Four DIMM slots support 4GB of dual-channel DDR 400/333/266 SDRAM ECC memory. While the board will run at 800MHz FSB when using DDR400, it's worth noting that when using DDR333 with 800MHz FSB, the memory actually runs at 230MHz.

Not many boards offer as much FireWire support: The 875P-NEO-FISR offers three FireWire ports. Two are 400Mbps ports, one of them a mini version. The third is available through a header on the motherboard.

Additional features include Intel Hyper-Threading technology, two SATA ports with RAID 0 and 1, support for 10/100 Ethernet MAC and PHY, and ACPI Power Management on the Intel 82547-EI with CSA (Communication Streaming Architecture) interface.

Other frills include an AGP 8X-compatible slot, five PCI slots, dual ATA/100/66 IDE DMA 66/100 IDE controllers (which are integrated on the ICH5R), SPDIF output, and RealTek ALC850 8-channel audio (also integrated on the ICH5R).

The 875PNEO-FISR also supports PIO and Bus Master operation modes. ▲



MSI 875PNEO-FISR	
Socket Type	Socket 478 Intel
Chipset	Intel 875P, ICH5R
Processor Support	Intel P4 with Intel Hyper-Threading Technology (800/533MHz FSB)
RAM Support	4GB Dual DDR-400/333/266, ECC
RAM Slots	4
Graphics Bus	AGP 8X
PCI Slots	5
SATA Ports	2 (RAID 0)
IDE	2-channel ATA/100
USB Ports	8 (2.0)
FireWire Ports	3
LAN	Ethernet 10/100
Integrated Audio	8-channel AC'97
Integrated Graphics	N/A
Other Features	N/A
Manufacturer	MSI
Phone	(626) 913-0828
URL	www.msicomputer.com
Price	$152

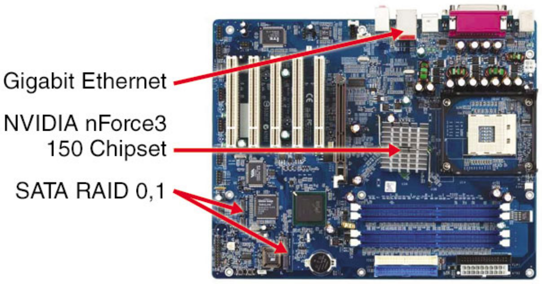
SHUTTLE AN50R

SHUTTLE tells us that the AN35N-L is the company's most popular AMD board, but the AN50R, based on NVIDIA's nForce 3 150 northbridge chipset and supporting the Athlon 64, is quickly gaining momentum. It is currently one of the company's most powerful boards.

The AN50R supports the Athlon 64 with HyperTransport Technology at an FSB speed of 1600MHz. At the same time it uses 3GB of DDR400/333/266/200 SDRAM on three DIMM slots. Although it offers just four USB ports, SHUTTLE makes up for that deficiency by including three FireWire ports and two SATA ports supporting RAID 0 and 1. The company even added an AGP 8X slot.

Some of the board's other features include Gigabit LAN, a total of five PCI slots, and ATA/133. Like many high-end boards, the AN50R also offers SPDIF digital audio in and out. However, while a lot of boards feature 8-channel built-in audio, the AN50R offers only 6-channel audio. For BIOS, Shuttle delivers its Award PnP BIOS, stored in 4MB of flash memory.

This board may not be feature heavy, but thanks in part to the chipset and integrated HyperTransport technology it offers plenty of speed. ▲



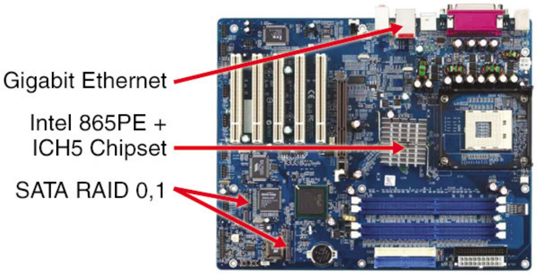
SHUTTLE AN50R	
Socket Type	Socket 754 AMD
Chipset	NVIDIA nForce3 150
Processor Support	Athon 64 with HyperTransport Technology (1600MHz FSB)
RAM Support	3GB DDR400/ 333/266/200
RAM Slots	3
Graphics Bus	AGP 8X
PCI Slots	5
SATA Ports	4 (RAID 0,1)
IDE	ATA/133/100
USB Ports	4 (2.0)
FireWire Ports	3
LAN	Gigabit LAN 10/100/1000
Integrated Audio	6-channel, SPDIF (In/Out)
Integrated Graphics	N/A
Other Features	N/A
Manufacturer	SHUTTLE
Phone	(626) 820-9000
URL	www.us.shuttle.com
Price	$141

SHUTTLE AB60R

Together, the AB60R and the AB60N form the cornerstone of SHUTTLE's Intel motherboard lineup. For this segment, we chose the more expensive (but not by much) AB60R.

The Intel 865PE and ICH5 chipsets form the basis of this Socket 478 board, which also supports P4 and Celeron processors at 800/533/400MHz FSB speeds. The AB60R supports 10/100/1000 Gigabit LAN with CSA (Communication Streaming Architecture) in addition to 4GB of dual-channel DDR400/333/266 SDRAM and up to four devices via two ATA/100 ports. It has four DIMM slots, an AGP 8X graphics slot, and five PCI slots.

Like SHUTTLE's AB50R AMD board, this one also offers hardware monitoring functions and an Award PnP BIOS with 4MB flash memory. To round out the list of the board's features, we have to mention its two FireWire ports, available through the onboard VIA 6306 chipset. The AB60R also allows you to add two SATA drives, each supporting RAID 0 and 1. For audio, the AB60R contains both SPDIF in and out, as well as 6-channel audio. Hardware monitoring is also included. ▲



SHUTTLE AB60R	
Socket Type	Socket 478 Intel
Chipset	Intel 865PE + ICH5
Processor Support	P4, Celeron (800/533/400MHz FSB)
RAM Support	4GB Dual DDR-400/333/266 SDRAM
RAM Slots	4
Graphics Bus	AGP 8X
PCI Slots	5
SATA Ports	4 (RAID 0,1)
IDE	ATA/100
USB Ports	8 (2.0)
FireWire Ports	2
LAN	Gigabit LAN 10/100/1000
Integrated Audio	6-channel
Integrated Graphics	N/A
Other Features	(No on-board VGA)
Manufacturer	SHUTTLE
Phone	(626) 820-9000
URL	www.us.shuttle.com
Price	$144

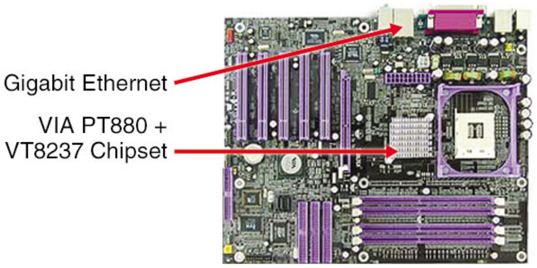
SOLTEK SL-PT880PRO-FGR

SOLTEK has yet to gain much ground in the United States, which is unfortunate because it manufactures several impressive motherboards. Take the SL-PT880Pro-FGR, for example. This Socket 478B board provides 4GB of unregistered, non-ECC DDR 400/333/266 DRAM with dual-channel support. It is founded on VIA's PT880 and VT8237 chipsets and combines speed with oodles of features (many of them optional).

Some of those features include Gigabit LAN, 6-channel AC'97 integrated audio, two FireWire ports (one integrated and one available through an optional cable), and three ATA connectors. One of those ATA connectors is an ATA/133/100 connector that supports up to two IDE devices and delivers RAID 0, 1, and 0+1. The other two support as many as four more IDE devices with ATA/133/100/66 connectors.

SOLTEK also added five PCI slots and one AGP 8X slot to the SL-PT880Pro-FGR in addition to the eight USB 2.0 ports (four integrated ports and four more available through optional cables).

The company could hardly have packed more features onto this board. Other niceties, besides hardware monitoring, include (the optional) RedStorm Overclocking Technology and RedStorm2 Overclocking Technology. ▲



SOLTEK SL-PT880Pro-FGR

Socket Type	Socket 478B Intel
Chipset	VIA PT880 + VT8237
Processor Support	P4, Celeron (800/533/400MHz FSB)
RAM Support	4GB Dual DDR-400/333/266 DRAM, unregistered, non-ECC
RAM Slots	4
Graphics Bus	AGP 8X
PCI Slots	5
SATA Ports	4 (2 VT8237 RAID 0, 1; 2 RAID 0, 1, 0+1)
IDE	2 ATA/133/100/66, 1 ATA/133/100 (RAID 0, 1, 0+1)
USB Ports	8 (2.0)
FireWire Ports	2
LAN	Gigabit LAN 10/100/1000
Integrated Audio	6-channel, AC'97
Integrated Graphics	N/A
Other Features	Hardware monitoring, Redstorm Overclocking Technology (optional), RedStorm2 Overclocking Technology
Manufacturer	SOLTEK
Phone	N/A
URL	www.soltek.com.tw
Price	N/A

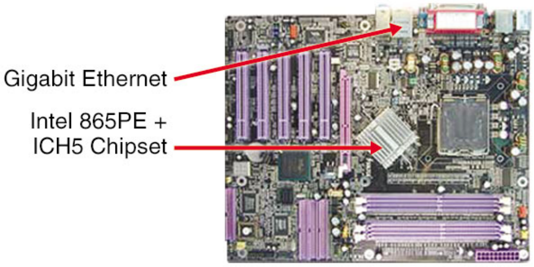
SOLTEK SL-865PRO-775

SOLTEK manages to one-up the SL-PT880Pro-FGR with the SL-865Pro-775, a Socket LGA 775 powered by Intel 865PE and ICH5 chipsets and supporting the Prescott Pentium 4 processor (800/533MHz FSB).

However, aside from the chipset and socket, you may notice many similarities between the two boards. The SL-865Pro-775 supports up to 4GB of dual-channel unregistered non-ECC DDR 400/333/266 DRAM memory through four slots. Two ATA/100/66/33 IDE connectors support up to 4 IDE devices and a third ATA133 connector supports RAID (0, 1, 0+1, and JBOD) via a Promise PDC20579 chip that also supports RAID through two SATA connectors. (The board has a total of four SATA ports.)

The standard expansion capabilities are also available with the SL-865Pro-775, meaning it has an AGP 8X slot and five PCI slots. Also, the SL-865Pro-775 won't leave you without high-speed device support because it has two FireWire ports and support for eight USB devices (four integrated, four available through optional cables).

After all that, the board offers Gigabit LAN, 6-channel AC'97-compatible audio, and hardware monitoring. Overclockers have further reason to rejoice: RedStorm Overclocking Technology is also available, but optional. ▲



SOLTEK SL-865Pro-775

Socket Type	Socket LGA 775 Intel
Chipset	Intel 865PE + ICH5
Processor Support	Prescott P4 (800/533MHz FSB)
RAM Support	4GB Dual DDR-400/333/266 DRAM, unregistered, non-ECC
RAM Slots	4
Graphics Bus	AGP 8X
PCI Slots	5
SATA Ports	4 (2 with RAID 0, 1, 0+1, JBOD)
IDE	2 ATA/100/66/33, 1 ATA/133 (RAID 0, 1, 0+1, JBOD)
USB Ports	8 (2.0)
FireWire Ports	2
LAN	Gigabit LAN 10/100/1000
Integrated Audio	6-channel, AC'97
Integrated Graphics	N/A
Other Features	Hardware monitoring, RedStorm Overclocking Technology (optional)
Manufacturer	SOLTEK
Phone	N/A
URL	www.soltek.com.tw
Price	N/A

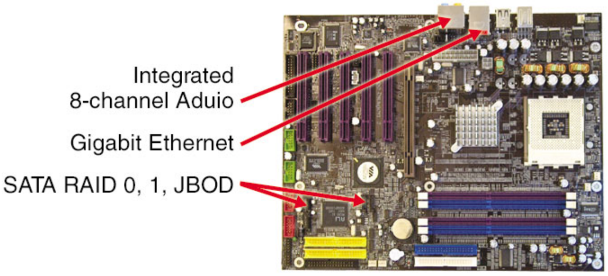
SOYO SY-KT880 DRAGON 2

The SY-KT880 DRAGON 2 with VIA KT880 chipset is SOYO's top-of-the-line AMD motherboard, and it's loaded with extras, such as RAID support for both parallel and serial ATA. In all, the board consists of four ATA ports supporting RAID 0, 1, 0+1, and JBOD, and four channels of SATA supporting RAID 0, 1, and JBOD available through an Ali M5281 chip. It also includes 10/100/1000 Gigabit LAN.

In addition, the board can handle up to 4GB of dual-channel DDR400 and supports AMD Athlon XP 1800+ to 3200+ with up to 400MHz FSB speed. Despite the lack of integrated graphics, AGP 8X expansion exists through an AGP Pro slot. Two FireWire ports and five PCI slots provide further expandability.

SOYO also built eight channels of audio into this board with C-Media CMI 9780 AC'97. In addition to the expanded surround sound, you'll also find support for SPDIF input and output.

Health monitoring for the SY-KT880 DRAGON 2 is provided by onboard voltage monitors, a CPU fan and CHA fan speed monitor, CPU temperature and CHA temperature monitor, and CPU overheat protection. ▲



SOYO SY-KT880 DRAGON 2	
Socket Type	Socket A AMD
Chipset	VIA KT880
Processor Support	Athlon XP (400/ 333/266MHz FSB)
RAM Support	4GB Dual DDR-400/333 SDRAM
RAM Slots	4
Graphics Bus	AGP 8X
PCI Slots	5
SATA Ports	4 (RAID 0, 1, JBOD)
IDE	ATA/133/100/66 (RAID 0, 1, 0+1, JBOD)
USB Ports	4 (2.0)
FireWire Ports	2
LAN	Gigabit LAN 10/100/1000
Integrated Audio	8-channel, SPDIF (In/Out)
Integrated Graphics	N/A
Other Features	On board voltage monitors, CPU temperature and CHA temperature monitor
Manufacturer	SOYO
Phone	(909) 292-2500
URL	www.soyousa.com
Price	N/A

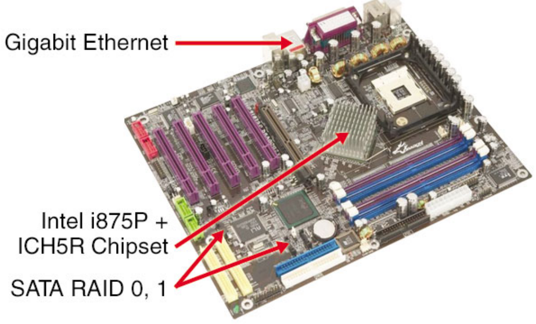
SOYO SY-P4I875P DRAGON 2 V1.0

SOYO's SY-P4I875P DRAGON 2 v1.0 varies only slightly from the SY-P4I875P Dragon 2 Platinum Edition.

Like the latter, the DRAGON 2 v1.0 with Intel 875P and ICH5R chipsets supports Intel's Hyper-Threading technology and lets you add up to 4GB of dual-channel DDR400/333 DDR SDRAM with ECC through four 184-pin DIMM sockets. The DRAGON 2 v1.0 also supports Intel P4 processors of up to 3.2GHz with 533MHz and 800MHz FSB speeds, and offers digital SPDIF outputs, 6-channel audio through a built-in CMI 8738 chip, three FireWire ports (one front port and two headers), and eight USB ports (four rear ports and four headers).

Also, like the Platinum Edition, the DRAGON 2 v.1.0 offers five 32-bit PCI slots, an AGP 8X video slot, and 4-channel SATA. The system-monitoring features are also the same, including such utilities as onboard voltage monitors for +3.3V, +12V, VCore, DIMM, and AGP.

But, unlike the Platinum Edition, this board supports an Intel Prescott processor of up to 3.4GHz at 800MHz FSB. It also includes a Sigma Box featuring a BayONE 9-in-1 USB 2.0 Flash Media Reader/Writer, and 4MB Flash ROM. ▲



SOYO SY-P4I875P DRAGON 2 V1.0	
Socket Type	Socket 478 Intel
Chipset	Intel i875P, ICH5R
Processor Support	P4, Celeron (800/533MHz FSB)
RAM Support	4GB Dual DDR400/333, ECC
RAM Slots	4
Graphics Bus	AGP 8X
PCI Slots	5 (v 2.2)
SATA Ports	4 (RAID 0, 1)
IDE	ATA/133 (RAID 0, 1, 0+1)
USB Ports	8 (2.0)
FireWire Ports	3
LAN	Gigabit LAN 10/100/1000
Integrated Audio	6-channel, SPDIF (Out)
Integrated Graphics	N/A
Other Features	N/A
Manufacturer	SOYO
Phone	(909) 292-2500
URL	www.soyousa.com
Price	$190

SUPERMICRO P4SCT+II

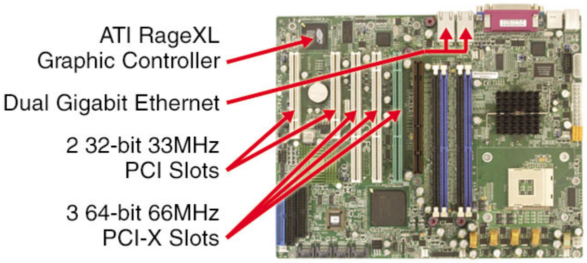
It's probably only natural that a board such as the P4SCT+II from Supermicro, which has been around for quite some time, leaves a little to be desired. Yet, whatever the board lacks, it makes up for in other ways.

For example, the P4SCT+II lacks integrated audio, which is pretty much standard on most boards. On the other hand, it does offer integrated graphics via an ATI RAGE XL SVGA PCI video controller with 8MB of memory.

The P4SCT+II also lacks FireWire ports. Instead, it includes six SATA connectors: two for HDD by Intel 6300ESB and four for HDD by Marvell SATA Controller. The latter supports RAID 0 and 1+0 while the former supports RAID 0 and 1.

In addition, this Socket 478 board supports 4GB of ECC, non-ECC unbuffered DDR400/333/266 SDRAM memory on four DIMM slots and has dual-channel support. It also supports 3.4GHz Intel Pentium 4 and 2.8GHz Celeron processors with Hyper-Threading technology at speeds of up to 800/533/400MHz.

Further expansion options and features include two PCI ports, Gigabit Ethernet LAN, AGP 8X graphics bus, and Hardware monitoring that includes 3-pin fan headers with tachometer monitoring. ▲



Supermicro P4SCT+II	
Socket Type	Socket 478 Intel
Chipset	Intel 875P
Processor Support	P4, Celeron (800/533/400MHz FSB)
RAM Support	4GB DDR400/333/266 SDRAM, unbuffered, ECC, non-ECC
RAM Slots	4
Graphics Bus	AGP 8X
PCI Slots	2
SATA Ports	6 (4 HDD RAID 0, 1 + 0), (2 HDD RAID 0, 1)
IDE	ATA/100
USB Ports	4 (2.0)
FireWire Ports	N/A
LAN	Dual LAN 10/100/1000
Integrated Audio	N/A
Integrated Graphics	ATI Rage XL SVGA
Other Features	Hardware monitoring, 3-pin fan headerswith tachometer monitoring
Manufacturer	Supermicro
Phone	(408) 503-8000
URL	www.supermicro.com
Price	N/A

SUPERMICRO P4SCT+

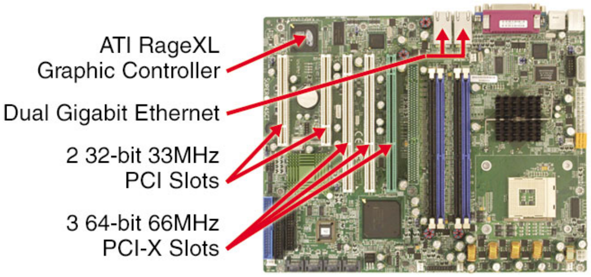
Supermicro also offers the P4SCT+, which provides 4GB of unbuffered dual-channel DDR400/333/266 SDRAM and four RAM slots. It's another Socket 478 board, but with an Intel E7210 (Canterwood ES) chipset instead of an Intel 875P.

Like the P4SCT+II, the P4SCT+ board offers no integrated audio. It also provides six SATA ports, four USB ports, no FireWire ports, and Intel Pentium 4/Celeron processor support.

Also like the P4SCT+II, this board offers a fairly generous range of system monitoring tools, including three 3-pin fan headers with tachometer monitoring, CPU and chassis temperature monitoring, and LED for CPU and system overheat.

For expansion, the P4SCT+ provides five PCI slots compared to the P4SCT+II's two. While two of the PCI slots on the P4SCT+ are 32-bit 33MHz slots, the other three are 64-bit 66MHz PCI-X slots.

However, unlike the P4SCT+II, this board lacks an AGP slot. It's possible that Supermicro dropped the AGP slot for the PCI-X slots and assumed that the integrated graphics (ATI RageXL 8MB with frame buffer) would suffice. ▲



Supermicro P4SCT+	
Socket Type	Socket 478 Intel
Chipset	Intel E7210 (Canterwood ES)
Processor Support	P4, Celeron (800/533/400MHz FSB)
RAM Support	4 GB DDR400/333/266 SDRAM, unbuffered, ECC, non-ECC
RAM Slots	4
Graphics Bus	N/A
PCI Slots	5
SATA Ports	6 (4 HDD RAID 0, 1+0), (2 HDD RAID 0, 1)
IDE	ATA/100
USB Ports	4 (2.0)
FireWire Ports	N/A
LAN	Dual LAN 10/100/1000
Integrated Audio	N/A
ntegrated Graphics	ATI Rage XL SVGA
Other Features	Hardware monitoring, three 3-pin fan headers with tachometer monitoring
Manufacturer	Supermicro
Phone	(408) 503-8000
URL	www.supermicro.com
Price	N/A

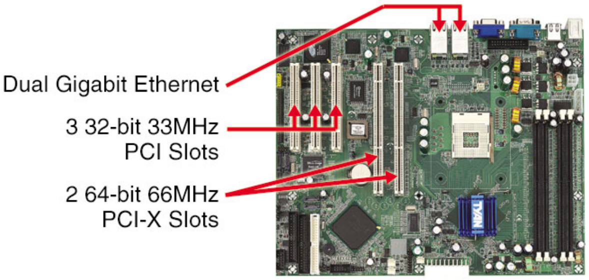
TYAN TOMCAT I7210

The new Tomcat i7210 with Intel E7210 chipset from Tyan offers a slew of decent features, but they'll cost you.

The board supports both Intel P4 Northwood or Prescott 800/533MHz FSB processors with 800MHz system bus, and a single 478-pin Celeron processor up to 2.8GHz. Some of the board's other features include PCI-X expansion support with two 64-bit PCI-X (3.3v) 66MHz slots, four-port SATA RAID (two with RAID 0, 1, and 4 with RAID 0, 1, and 1+0), dual Intel Gigabit Ethernet LAN ports, 4GB of unbuffered PC3200/2700 DDR400 ECC or non-ECC memory in four DDR DIMM sockets, and IPMI 1.5 remote management.

The board includes a variety of other slots and ports, including a floppy connector for up to two drives and four USB 2.0 and two optional front USB ports via optional cable. Some of the system management features include seven 3-pin tachometer headers (five with PWM control), 3-pin chassis intrusion header, temperature and voltage monitoring, IPMD connector, and watchdog timer. The Tomcat i7210 also provides Tyan M3289 SMDC support via 2 x 25 pin header.

There's also an ATI Rage XL PCI controller with 8MB SDRAM frame buffer, but the board lacks an AGP slot, which is an absolute must-have for some buyers. ▲



Tyan Tomcat i7210	
Socket Type	Socket 478 Intel
Chipset	Intel E7210, 6300ESB Hance Rapids
Processor Support	P4, Celeron (800/533MHz FSB)
RAM Support	4GB DDR400, ECC, non-ECC
RAM Slots	4
Graphics Bus	N/A
PCI Slots	5 (2 64-bit PCI-X [3.3v] 66MHz slots, 3 32-bit 33MHz PCI 2.2 [5v] slots)
SATA Ports	6 (2 RAID 0, 1) (4 RAID 0, 1, 1+0)
IDE	ATA/100/66/33
USB Ports	4 (2.0)
FireWire Ports	N/A
LAN	Dual Gigabit LAN (optional)
Integrated Audio	N/A
Integrated Graphics	ATI Rage XL
Other Features	Seven 3-pin tachometer headers, 3-pin chassis intrusion header, temperature and voltage monitoring, IPMD connector
Manufacturer	Tyan
Phone	(510) 651-8868
URL	www.tyan.com
Price	$312

TYAN TIGER K8W

Tyan's Tiger K8W is the company's cost-effective value dual AMD Opteron board with many of the same features as the company's Thunder K8W, the flagship dual AMD Opteron board for workstations.

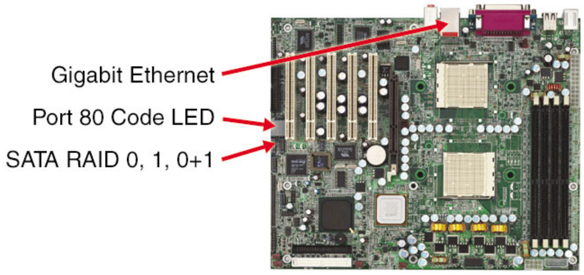
This Socket 940 board has four DIMM sockets and offers a whopping 8GB of registered DDR400/333/266/200 ECC and non-ECC memory.

Unlike the Tyan Tomcat i7210 described above, all five PCI slots are 32-bit 33MHz (5V) slots, so the Tiger K8W doesn't have any PCI-X slots. However, the K8W does have an AGP 8X slot while the Tomcat does not.

Other features include 4-channel SATA RAID (0, 1, 0+1), Gigabit Ethernet, 6-channel AC '97 audio codec, FireWire, two USB 2.0, two USB 1.1, one Gigabit LAN port, and dual-channel ATA/133/100/66 drives supporting up to four IDE devices.

Furthermore, the Tiger K8W includes hardware monitoring with port 80 code display LED, six 3-pin fan headers with tachometer monitoring, temperature monitoring, voltage monitoring, and even an ATX power support providing for an ATX 12V power supply.

It may cost $327, but the Tiger K8W is well worth the price. ▲



Tyan Tiger K8W	
Socket Type	Socket 940 AMD
Chipset	AMD 8151, 8111
Processor Support	2 Opteron
RAM Support	8GB PC3200/ 2700/2100/1600 DDR, registered
RAM Slots	4
Graphics Bus	AGP 8X
PCI Slots	5
SATA Ports	4 (RAID 0, 1, 0+1)
IDE	ATA/133/100/66
USB Ports	2 (2.0); 2 (1.1)
FireWire Ports	2
LAN	Dual Gigabit LAN 10/100/1000
Integrated Audio	6-channel, AC'97
Integrated Graphics	N/A
Other Features	Six 3-pin fan headers (three with tachometer monitoring), temperature and voltage monitoring, port 80 code display LED
Manufacturer	Tyan
Phone	(510) 651-8868
URL	www.tyan.com
Price	$327

RAM-PING UP YOUR SYSTEM

We Chart The Top Modules From The Top Manufacturers

We charted the highest-speed DDR modules from top manufacturers, as well as the available DDR2 modules. With manufacturers that offer multiple levels of RAM, we excluded lower-priced modules in favor of those better for overclocking. We also left out modules that differed only by heat spreader color. For most modules, we listed the timing settings, but when timings weren't available, we listed the CAS (column address strobe) latency. We listed unavailable specifications as N/A, for not available.

by Andrew Leibman

DDR2 533 PC2-4300 & 4200

Manufacturer	Module Product Number	Density	Latency	Registered	ECC	Voltage	Package
Crucial	CT12864AA53E	1GB	N/A	Unbuffered	Non-ECC	1.8V	240
	CT6464AA53E	512MB	4	Unbuffered	Non-ECC	1.8V	240
	CT3264AA53E	256MB	4	Unbuffered	Non-ECC	1.8V	240
Kingston	KVR533D2N4/1G	1GB	4	Unbuffered	Non-ECC	1.8V	240
	KVR533D2N4/512	512MB	4	Unbuffered	Non-ECC	1.8V	240
	KVR533D2N4/256	256MB	4	Unbuffered	Non-ECC	1.8V	240
	KVR533D2E4/1G	1GB	4	Unbuffered	ECC	1.8V	240
	KVR533D2E4/512	512MB	4	Unbuffered	ECC	1.8V	240
	KVR533D2E4/256	256MB	4	Unbuffered	ECC	1.8V	240
Corsair	CM2X512-4200	512MB	4-4-4-12	Unbuffered	Non-ECC	1.8V	240
	CM2X256-4200	256MB	4-4-4-12	Unbuffered	Non-ECC	1.8V	240
	TWIN2X1024-4200	1GB	4-4-4-12	Unbuffered	Non-ECC	1.8V	2 x 240
	TWIN2X512-4200	512MB	4-4-4-12	Unbuffered	Non-ECC	1.8V	2 x 240

DDR 533 PC4300, *DDR 533 PC4200, **DDR 550 PC4400

Manufacturer	Module Product Number	Density	Latency	Registered	ECC	Voltage	Package
Kingston	KHX4300K2/1G	1GB	3-4-4-8-1	Unbuffered	Non-ECC	2.7V	2 x 184
	KHX4300K2/512	512MB	3-4-4-8-1	Unbuffered	Non-ECC	2.7V	2 x 184
	KHX4300/512	512MB	3-4-4-8-1	Unbuffered	Non-ECC	2.7V	184
	KHX4300/256	256MB	3-4-4-8-1	Unbuffered	Non-ECC	2.7V	184
Corsair	TWINX1024-4400**	1GB	3-4-4-8	Unbuffered	Non-ECC	2.75V	2 x 184
	CMX512-4400**	512MB	3-4-4-8	Unbuffered	Non-ECC	2.75V	184
OCZ Technology	OCZ550512ELDCGLE-K**	512MB	2.5-4-4-8	Unbuffered	Non-ECC	2.85V	2 x 184
	OCZ5501024ELDCGLE-K**	1GB	2.5-4-4-8	Unbuffered	Non-ECC	2.85V	2 x 184
	OCZ550512ELGLE**	256MB	2.5-4-4-8	Unbuffered	Non-ECC	2.85V	184
	OCZ5501024ELGLE**	512MB	2.5-4-4-8	Unbuffered	Non-ECC	2.85V	184
	OCZ533512ELDC-K	512MB	2.5-4-4-7	Unbuffered	Non-ECC	2.8V	2 x 184
	OCZ5331024ELDC-K	1GB	2.5-4-4-7	Unbuffered	Non-ECC	2.8V	2 x 184
	OCZ533256EL*	256MB	2.5-4-4-7	Unbuffered	Non-ECC	2.8V	184
	OCZ533512EL*	512MB	2.5-4-4-7	Unbuffered	Non-ECC	2.8V	184
	OCZ550512PFDC-K**	512MB	3-4-4-8	Unbuffered	Non-ECC	2.8V	2 x 184
	OCZ5501024PFDC-K**	1GB	3-4-4-8	Unbuffered	Non-ECC	2.8V	2 x 184
	OCZ533512PFDC-K*	512MB	3-4-4-8	Unbuffered	Non-ECC	2.8V	2 x 184
	OCZ5331024PFDC-K*	1GB	3-4-4-8	Unbuffered	Non-ECC	2.8V	2 x 184
	OCZ533256PF*	256MB	3-4-4-8	Unbuffered	Non-ECC	2.8V	184
	OCZ533512PF*	1GB	3-4-4-8	Unbuffered	Non-ECC	2.8V	184
Geil	GL5124400DC**	512MB	3-8-4-4	Unbuffered	Non-ECC	2.6V	2 x 184
	GL1G4400DC**	1GB	3-8-4-4	Unbuffered	Non-ECC	2.6V	2 x 184
	GL5124200DC*	512MB	3-8-4-4	Unbuffered	Non-ECC	2.6V	2 x 184
	GL1G4200DC*	1GB	3-8-4-4	Unbuffered	Non-ECC	2.6V	2 x 184

DDR 500 PC4000

Manufacturer	Module Product Number	Density	Latency	Registered	ECC	Voltage	Package
Kingston	KHX4000K2/1G	1GB	3-4-4-8-1	Unbuffered	Non-ECC	2.6V	2 x 184
	KHX4000K2/512	512MB	3-4-4-8-1	Unbuffered	Non-ECC	2.6V	2 x 184
	KHX4000/512	512MB	3-4-4-8-1	Unbuffered	Non-ECC	2.6V	184
	KHX4000/256	256MB	3-4-4-8-1	Unbuffered	Non-ECC	2.6V	184
Corsair	TWINX1024-4000PRO	1GB	3-4-4-8	Unbuffered	Non-ECC	2.75V	2 x 184
	TWINX1024-4000	1GB	3-4-4-8	Unbuffered	Non-ECC	2.75V	2 x 184
	TWINX512-4000	512MB	3-4-4-8	Unbuffered	Non-ECC	2.75V	2 x 184
	CMX512-4000PRO	512MB	3-4-4-8	Unbuffered	Non-ECC	2.75V	184
	CMX512-4000	512MB	3-4-4-8	Unbuffered	Non-ECC	2.75V	184
	CMX256A-4000	256MB	3-4-4-8	Unbuffered	Non-ECC	2.75V	184
OCZ Technology	OCZ500512ELDCGE-K	512MB	2.5-4-4-7	Unbuffered	Non-ECC	2.8V	2 x 184
	OCZ5001024ELDCGE-K	1GB	2.5-4-4-7	Unbuffered	Non-ECC	2.8V	2 x 184
	OCZ500512ELGE	256MB	2.5-4-4-7	Unbuffered	Non-ECC	2.8V	184
	OCZ5001024ELGE	512MB	2.5-4-4-7	Unbuffered	Non-ECC	2.8V	184
	OCZ500512ELDC-K	512MB	3-4-4-8	Unbuffered	Non-ECC	2.8V	2 x 184
	OCZ5001024ELDC-K	1GB	3-4-4-8	Unbuffered	Non-ECC	2.8V	2 x 184
	OCZ500256EL	256MB	3-4-4-8	Unbuffered	Non-ECC	2.8V	184
	OCZ500512EL	512MB	3-4-4-8	Unbuffered	Non-ECC	2.8V	184
Mushkin Enhanced Memory Systems	1GB (2 x 512MB) PC4000 DDR	1GB	3	Unbuffered	Non-ECC	2.5V	2 x 184
	512MB (2 x 256MB) PC4000 DDR	512GB	3	Unbuffered	Non-ECC	2.5V	2 x 184
	512MB PC4000 DDR	512MB	3-4-4	Unbuffered	Non-ECC	2.5V	184
	256MB PC4000 DDR	256MB	3-4-4	Unbuffered	Non-ECC	2.5V	184
Geil	GL5124000DC	512MB	2.5-7-4-4	Unbuffered	Non-ECC	2.6V	2 x 184
	GL1G4000DC	1GB	2.5-7-4-4	Unbuffered	Non-ECC	2.6V	2 x 184
	GD4000-512DC	512MB	2.5-7-4-4	Unbuffered	Non-ECC	2.55V	2 x 184
	GD4000-1GDC	1GB	2.5-7-4-4	Unbuffered	Non-ECC	2.55V	2 x 184
Kingmax	MPTC22D-38KS4G-PAA (TinyBGA)	512MB	3	Unbuffered	Non-ECC	2.6V	184
	MPTC22D-38HT4-HGA (TSOP)	512MB	3	Unbuffered	Non-ECC	2.6V	184
	MPTB62D-38KS4G-PAA (TinyBGA)	256MB	3	Unbuffered	Non-ECC	2.6V	184
	MPTB62D-38HT4-HGA (TSOP)	256MB	3	Unbuffered	Non-ECC	2.6V	184

DDR 466 PC3700, *DDR 433 PC3500, **DDR 434 PC3500

Manufacturer	Module Product Number	Density	Latency	Registered	ECC	Voltage	Package
Kingston	KHX3700/256	256MB	3-4-4-8-1	Unbuffered	Non-ECC	2.6V	184
	KHX3700/512	512MB	3-4-4-8-1	Unbuffered	Non-ECC	2.6V	184
	KHX3700K2/512	512MB	3-4-4-8-1	Unbuffered	Non-ECC	2.6V	2 x 184
	KHX3700K2/1G	1GB	3-4-4-8-1	Unbuffered	Non-ECC	2.6V	2 x 184
	KHX3700K2/2G	2GB	3-4-4-8-1	Unbuffered	Non-ECC	2.6V	2 x 184
Corsair	TWINX1024-3700	1GB	3-4-4-8	Unbuffered	Non-ECC	2.6V	2 x 184
	TWINX512-3700	512MB	3-4-4-8	Unbuffered	Non-ECC	2.6V	2 x 184
	CMX512-3700	512MB	3-4-4-8	Unbuffered	Non-ECC	2.6V	184
	CMX256A-3700	256MB	3-4-4-8	Unbuffered	Non-ECC	2.6V	184
	TWINX1024RE-3500LLPT*	1GB	2-3-2-6	Registered	ECC	2.6V	2 x 184
	CMX512RE-3500LLPT*	512MB	2-3-2-6	Registered	ECC	2.6V	184
OCZ Technology	OCZ466512EBDCPE-K	512MB	3-3-2-8	Unbuffered	Non-ECC	2.8V	2 x 184
	OCZ4661024EBDCPE-K	1GB	3-3-2-8	Unbuffered	Non-ECC	2.8V	2 x 184
	OCZ433512EBDCPE-K**	512MB	2.5-3-2-8	Unbuffered	Non-ECC	2.8V	2 x 184
	OCZ4331024EBDCPE-K**	1GB	2.5-3-2-8	Unbuffered	Non-ECC	2.8V	2 x 184
	OCZ4332048EBPDCPE-K**	2GB	2.5-3-2-8	Unbuffered	Non-ECC	2.8V	2 x 184
	OCZ466256EBPE	256MB	3-3-2-8	Unbuffered	Non-ECC	2.8V	184
	OCZ466512EBPE	512MB	3-3-2-8	Unbuffered	Non-ECC	2.8V	184
	OCZ433256EBPE**	256MB	2.5-3-2-8	Unbuffered	Non-ECC	2.8V	184
	OCZ433512EBPE**	512MB	2.5-3-2-8	Unbuffered	Non-ECC	2.8V	184
	OCZ4331024EBPE**	1GB	2.5-3-2-8	Unbuffered	Non-ECC	2.8V	184

To view more memory specs online, go to www.cpumag.com/modder2/memory.

MODDING Q&A

We Answer Your Pressing Questions

Regardless of where you go or what you're doing, day or night, you're bound to encounter some sort of "mod" on a regular basis. Simply walk through a mall, for example, and you'll likely see myriad people talking on their cell phones. Odds are some of them will have a custom case or a brightly colored lighted antenna. And how about those snazzy ring tones! How many times have you been in a restaurant and had to hear a chorus of "Heya" blaring from a Motorola i730 that's "ringing" at the table next to you? It's probably been one time too many.

It seems that no matter what the item is, whether it be a cell phone, a car, or a computer, we're all compelled to make the one we own unique in some way, shape, or form. This desire to personalize our possessions has spawned entire industries, with millions of dollars being spent worldwide, and true PC enthusiasts are arguably the most passionate contingent. Consult the oracle (Google), search for "PC Mods," and you'll see exactly what I mean. The ensuing 1.9+ million results will give you an idea as to the sheer number of avid PC modders who are showcasing their talents worldwide.

If you'd like to join this talented bunch but aren't quite sure where to begin, we may be able to help. In this article, we're going to answer some of the most commonly asked modding-related questions. After reading through the next few pages, you'll be armed with the basic knowledge necessary to turn your "me too" PC into a one-of-a-kind, eye-catching rig!

Q **What is a mod?**

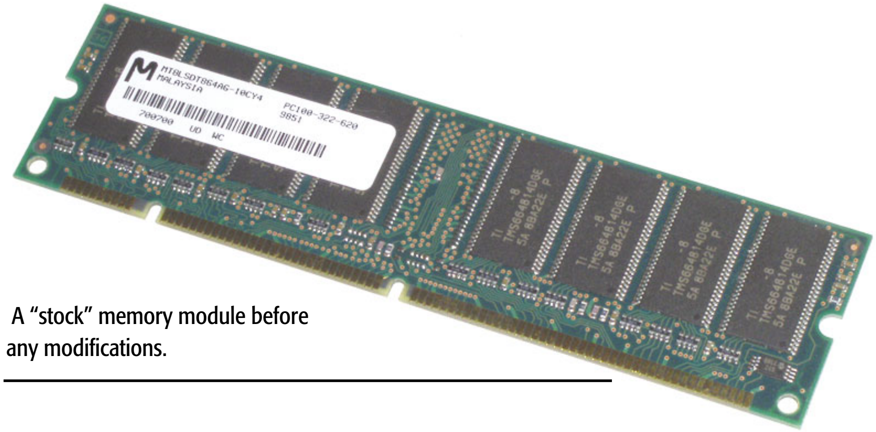
A To put it simply, the term "mod" is short for "*mod*ification." Essentially, any change made to a system that alters its stock configuration in some way can be called a mod. Some popular mods include replacing stock CPU coolers, cutting windows into your case, installing extra case fans, or even something as simple as changing a BIOS setting to wring more performance from the system. These are just a few examples, as there are an infinite number of things you can do to mod a system.

Q **Why would I want to mod my system?**

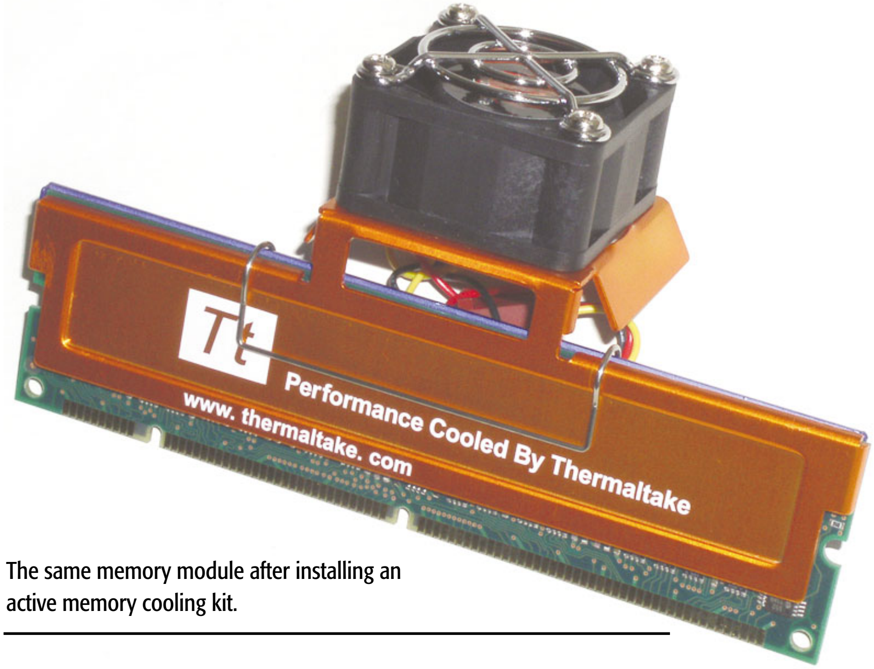
A One of the most popular reasons is to increase certain aspects of the system's performance, but some users mod their systems to make them more quiet or to simply make the system look unique. Modding also gives you that proud sense of accomplishment that comes only when you've completed a difficult project. Plus, there's nothing like strutting into the next big LAN party with a totally tricked-out rig. Just be prepared to sacrifice some gaming time to field questions.

Q **Can I mod my CPU or motherboard?**

A Yes you can; in fact, you can mod virtually any part of your system in some way. Depending on the type of CPU you own, there are some physical modifications you can make to it. For example, AMD's Athlon XP line of processors has traces along the top than you can manipulate to alter the CPU's default voltage, FSB, and multiplier. Intel's Pentium 4 processors aren't as easy to modify, but there are some popular tricks out there for them, as well. You can alter the default voltage for the Socket 478 Pentium 4, for example, by wrapping a specific set of pins on its underside with a thin strand of wire. It's also common practice to "lap" the Pentium 4's integrated heat spreader for better cooling. Lapping the heat spreader removes any miniscule peaks or valleys from the metal and makes is almost perfectly flat and smooth. This lets the heat spreader make better contact with the heatsink. When the CPU and its heatsink make better contact with each other, heat is more efficiently drawn away from the processor's core and that means lower temperatures. Some more hardcore modders will even go so far as to remove the Pentium 4's integrated heat spreader altogether for "direct die cooling," which brings us to the Athlon 64 and Opteron. At the moment, there aren't many physical mods specific to AMD's Athlon



A “stock” memory module before any modifications.



The same memory module after installing an active memory cooling kit.

64/Opteron processors. Like the Pentium 4, though, lapping or removing their integrated heat spreaders is increasingly becoming more common.

You can also modify processors by changing their operating frequencies. This practice is known as overclocking when you increase the CPU’s speed, or underclocking when it's decreased. A CPU’s operating frequency is derived by multiplying its FSB (frontside bus) by its multiplier. A 2.4GHz Pentium 4, for example, has a multiplier of 12 with an FSB of 200MHz. You can alter the CPU’s operating frequency by raising or lowering the speed of the FSB via your motherboard’s BIOS. Underclocking usually has no adverse affects other than lower performance, but overclocking a CPU will occasionally require a bump in voltage and will generate more heat, so adding more/better cooling may be necessary. (We’ll get into some cooling mods a little later.)

Motherboards can also be modified in a variety of ways. Some modders will replace stock northbridge coolers with more powerful units, and a multitude of “volt mods” are also quite common. Volt modding a motherboard usually requires soldering a resistor or potentiometer to a specific set of leads on one of the board’s voltage regulators. Doing so usually makes higher voltages available to the northbridge, southbridge, CPU, or memory. And with these higher voltages available, the system can usually be overclocked to higher speeds. A motherboard’s VRM (voltage regulation module) can be modified, as well. The VRM is usually the hottest running part of a motherboard, so mounting heatsinks to the MOSFETs (metal oxide semiconductor field effect transistors) is done to decrease their operating temperatures, which in turn will increase their lifespan and may make the whole system more stable. ABIT, MSI, and Chaintech have even begun installing custom VRM cooling on their high-end motherboards at the factory.

Q What about my memory or video card?

A Memory modules are probably the least modified component because properly functioning memory is absolutely essential for a system to remain stable. Memory is much less forgiving than some other components when it’s run out of spec. The voltage regulators feeding power to the memory modules are frequently modified but not the memory modules themselves. About the only physical changes made to memory modules are for enhancing their cooling. Adding heat spreaders will lower the memory’s operating temperature, which may allow for higher stable overclocks. Like CPUs, memory can be overclocked, as well. Your memory’s speed is directly tied to the system’s FSB. By raising or lowering the FSB in your system BIOS, you’re also changing the speed at which your memory is operating unless there is an option to “lock” it at one designated speed. Many motherboards also have a BIOS option available that gives users the ability to change the FSB to memory speed ratio. When set to 1:1, your memory will run at the same speed as the FSB, but when set to 5:4, your memory will run at 80% of the FSB’s speed. Having the ability to change the FSB-to-memory ratio comes in very handy during extreme overclocking because the FSB can be raised to speeds much higher than the memory can handle.

When compared to system memory, video cards are at the other end of the spectrum altogether. They are probably the most regularly modded computer component. There are software hacks that can make one card function and perform like another. These "soft-mods," as they are called, are especially popular with ATI's Radeon 9500 and 9800 line of GPUs. Video card hardware is also modified in many different ways. GPU coolers can be replaced with more powerful units. Volt Mods are done to supply more power to the GPU and onboard memory. And memory modules are regularly retrofitted with custom heatsinks—the list goes on and on. When some modders get done tweaking their video cards, it's not uncommon for them to look nothing like they did when they were in their stock forms.

Some of the easiest cooling mods are done by substituting or adding case fans.

Q **Can I modify my system's cooling?**

A Of course you can. Enhancing a system's cooling scheme is perhaps the most popular type of mod. Proper cooling is essential for overclocking and stability. Heat is every electronic component's worst enemy, so increasing your rig's cooling performance is always a good idea. Swapping out some parts can also turn a system that sounds like a jet engine into a whisper-quiet rig that wouldn't disturb a soul.

Some of the easiest cooling mods are done by substituting or adding case fans. Most ATX cases have vacant locations where you can simply snap a fan into place. But keep in mind that too many fans can be overkill. Essentially, you should plan to have the same amount of warm air being expelled from the case as you have cool air being drawn into it. If you'd like to add a fan where there wasn't one before, it's usually a matter of scribing a template and simply drilling a few holes. Installing a blowhole, an exhaust fan at the top of a tower case, is a common and very effective cooling mod. Blowholes expel the warm air that tends to build up at the top of a tower case, behind the 5.25-inch drive bays, and usually bring case temperatures way down. (See the Spring 2004 special issue of *PC Modder* for details on installing your own blowhole.)

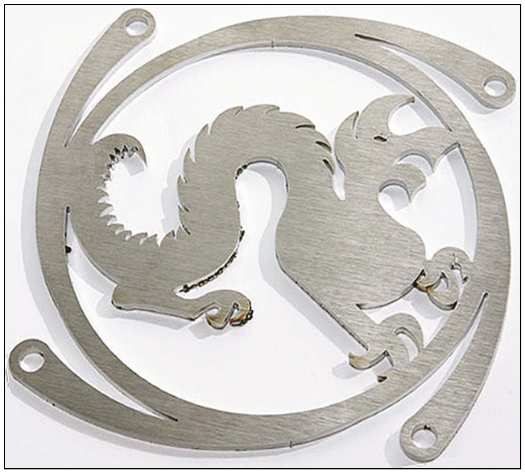
Replacing heatsinks with more capable models is also a popular type of cooling mod. The stock heatsinks included with "boxed" processors and the stock coolers installed on most video cards can easily be replaced by more efficient solutions. Aftermarket products from companies like Thermaltake, Vantec, and Swiftech can be used in place of the stock coolers, and they usually offer much better performance. Zalman also makes a few large, completely passive, heat-pipe-cooling kits that don't generate any noise. If you want to silence your PC, Zalman makes some great products and you won't have to sacrifice much performance to keep the noise level down.

Heatsinks like Swiftech's MCX6400-V for AMD Athlon 64 and Opteron processors are far more effective that the stock coolers that ship with AMD's and Intel's boxed CPUs.

Q **What is the benefit of modding my CPU cooler? What about my GPU cooler?**

A The three main benefits to modifying your CPU or GPU coolers are better cooling performance, more attractive aesthetics, and a lower noise level. Most stock CPU coolers are plain and offer just enough performance to keep a processor running within its specified thermal limits. When installed properly, upgrading to a more capable aircooler or upgrading to a more exotic watercooling kit will lower your processor's temperature considerably. Lower temperatures are always desirable, particularly when overclocking a system. Lower temperatures usually yield higher overclocks, which equates to more performance. And quite frankly, some aftermarket coolers are also much nicer to look at. If you've got yourself a snazzy, windowed case, it's almost sacrilegious to show off your system's innards when all you're sporting is a stock cooler. The aftermarket replacement coolers available for video cards offer all of the same benefits of CPU coolers, as well.

If your system is extremely loud, due to noisy fans mounted to your CPU and GPU coolers, you can quiet it down considerably with some of the silent, or near-silent cooling products currently available. Thermaltake and Zalman both make passive coolers that don't generate any noise at all. Couple one of these passive coolers with a near-silent fan, like the ones available at SilenX.Com, and you'll have yourself a high-performing cooling setup that generates little more noise than a whisper.



Custom, laser-cut fan guards are great for adding a little something to an otherwise plain case.

Thermaltake's Xaser line of premodded cases are popular amongst the overclocking community.

Q **My case needs some more flash. What should I do?**

A There are a plethora of options available to users looking to jazz up their cases. If you're not good with your hands or just aren't comfortable using power tools, there are quite a few companies offering premodded cases with side windows, lighted fans, glossy paint jobs, and fan controllers already integrated into their designs. Thermaltake, Lian-Li, and Cooler Master are some popular choices. They've got a wide variety of cases available in almost any color, shape, or size. If you're a do-it-yourself kind of person, however, you can get really creative with the right plan.

Cutting an unusually shaped window into your case is an excellent way to spruce up its appearance. First, remove the side panel from the case. Then affix an even layer of masking tape to the panel and draw out your desired shape. I like to design windows that don't expose the power supply or hard drives. Doing things this way makes it much easier to hide cables and will give the overall impression that the inside of your case is neat and clean. This isn't an excuse to have a rat's nest of cables in your case, though. Make sure you've taken the time to route cables neatly and use wire ties to bundle unused PSU cables in an inconspicuous location. With the masking tape laid down and your shape drawn out, drill a starter hole and proceed to cut out the shape with a jigsaw. And always use a sharp blade—it makes the work go much easier. After you've cut out the window, file down the edges to get rid of any sharp burrs in the metal, and you're almost done. Outline the perimeter of the window with some rubber molding and mount the actual windowpane (usually with some sort of double-sided adhesive or screws) and you're done.

Another great option is to replace the plain fan grilles on your power supply and the plain grilles on your case with custom models available at multiple online resellers. Fan grilles are available in all sizes, shapes, and colors. Some are laser cut from metal and some are molded plastic with lighted cathodes built right in. There are even fan grilles that pay tribute to popular characters like Spiderman or The Punisher. Do some shopping, and you're almost guaranteed to find something you like. And if you don't find anything, you could always make your own.

Adding colored lights and lighted fans can also take a system to the next level. Strategic placement of colored cold-cathodes and lighted fans will illuminate your system's innards. The effect is especially impressive in a system with a custom etched window. The resulting glow from an exciting lighting scheme is sure to grab the attention of fellow enthusiasts.

Before attempting any of these mods, pay special attention to your case's internal layout and come up with solid plan of attack. I can't tell you how many times I've seen someone mount a fan in a newly cut location, only to find they didn't account for a drive or card that encroaches on the same position. "If you don't plan to succeed, plan to fail." "Measure twice, cut once!" Basically, all of the clichés you've heard during an episode of "This Old House" apply here.

Q **What tools do I need to mod my case?**

A Aside from a standard computer toolkit (screwdrivers, pliers, etc), a spring-loaded center punch, a power drill, a jigsaw, hole saws of varying sizes, and a rotary tool should be considered required equipment. And anytime power tools are used for cutting and grinding, protective goggles, ear protection, and gloves are also a must. A fully decked-out, modded system is über-cool, but not if it comes at the expense of an injury.

The center punch is an oft-overlooked tool that makes drilling holes much easier. A center punch is usually made of a hard metal and is used to make small divots in a material before it is drilled. Drilling into smooth metals can be difficult because the drill bit doesn't always "bite" right away. This causes the drill to slide around, which will mar the surface. Making a small divot in which to place the drill bit makes it

A spring-loaded center punch, like the one shown here, is used to make small divots, which makes drilling holes in slick materials much easier.

A hole saw makes it relatively easy to cut perfect circles, which makes them useful for cutting in blowholes. Just make sure the hole saw you're using is designed for cutting metal.

A rotary tool, like this Dremel, is an excellent tool for cutting, grinding, and polishing metal or plastic.

much easier to keep the drill on one position, which is essential to do a quality job.

Jigsaws are a great tool for making precise cuts that don’t always run perfectly straight. When used in conjunction with some strategically placed pilot holes, jigsaws make cutting odd shapes fairly easy. Hole saws are also great for precise cutting, as well, but they serve a slightly different purpose. Hole saws are mounted to a power drill and are used to make perfectly circular cuts. (This is ideal for mounting fans.)

To rotary tool is kind of the jack-of-all-trades tool. A powerful, high-end rotary tool, when coupled with the right bits, can actually replace the drill and the jigsaw. I find they’re much better suited for smaller jobs, like grinding and polishing, but some people like to use rotary tools for larger projects. For precision cutting of smaller objects, like bay covers, for example, rotary tools are fantastic.

Q What’s the best way to add some color?

A There are four main ways to convert your plain box into a colorful work of art. The most common is paint. The ordinary spray paint available at your neighborhood hardware store is adequate for most jobs, provided the materials are properly prepared for painting. Those of you looking for a more professional appearance should look to airbrushes and higher quality enamel paints, however. If you’ve got a plain aluminum case, anodizing is another excellent option. Anodizing, which requires specialized chemicals and equipment, is the process of electroplating a metal, usually aluminum, with a colorized, protective coating. You’ll probably have to bring your case to a local plating company to have it anodized though, so plan on taking a quick trip through the Yellow Pages to find a shop nearby. We detailed the anodizing process in the May 2004 issue of *CPU*; check it out if you’d like to see it explained in greater detail.

Adding color to metal is one thing, but plastic presents a whole other challenge. The plastic-safe model paints available at most hobby shops work well. Dyes are a much better option though, and they’re easier to use than you might think. Generally, all you have to do is boil some water and add the dye until you achieve the desired color. Then dip the plastic into the solution for a half an hour or so and that’s it. The dye will permeate the plastic, so it can’t be scratched off, which makes it a very durable option.

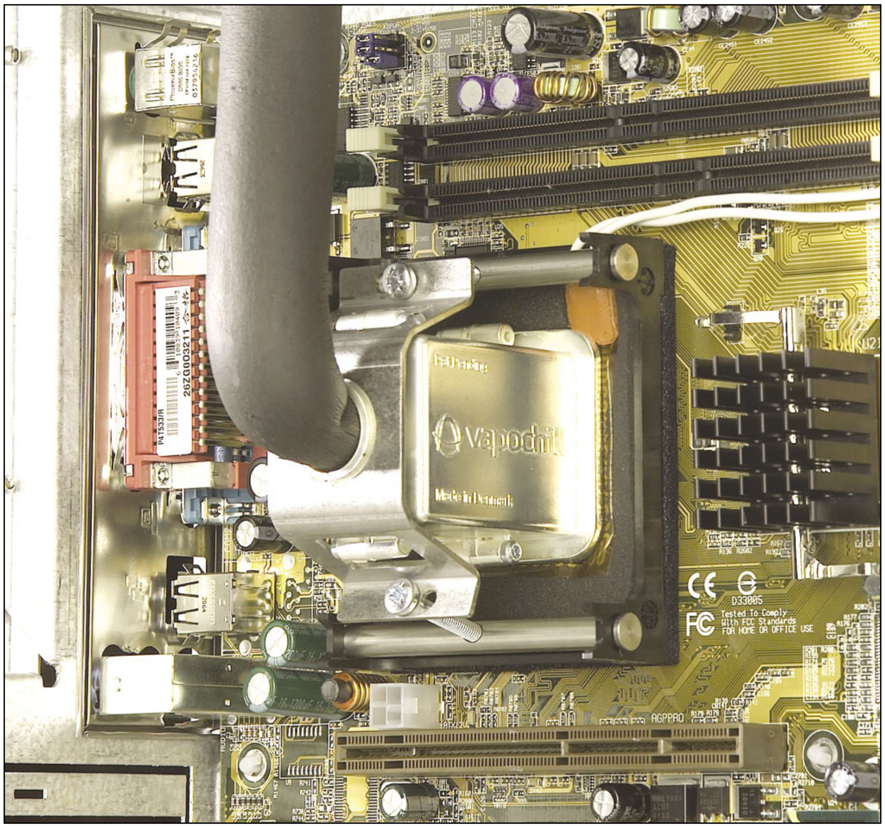
Another, much easier, way to add some color is with cold-cathodes, neon tubes, or lighted fans. Strategically placed cold-cathodes or lighted fans will make your system glow and will drastically change its overall appearance.

Q What are some of the more advanced tricks of the trade?

A As is the case with all things PC, there are exotic options available to those with the budgets and courage to take their systems to the extreme. On the cooling front, watercooling kits and vapor-phase coolers are used to bring CPU, GPU, and even chipset temperatures way down. Some even uses watercooling and vapor-phase cooling in the same system for the utmost in cooling performance. Products like Asetek’s Waterchill and Vapochill are two relatively expensive popular options, but for those who want nothing but the best for their rigs, there isn’t much better. The Vapochill uses technology that’s normally found in refrigerators to bring processor temperatures down below freezing. I’ve actually had a 3.4GHz Pentium 4 Extreme Edition overclocked to 4GHz in a Vapochill, and at idle, the processor’s internal thermal diode was reporting a temperature of only 28.4 degrees Fahrenheit (-2 degrees Celsius). With a stock Intel heatsink in the same system, with the same CPU overclocked to “only” 3.7GHz, temperatures climbed to over 123 F (51 C). Couple that kind of horsepower with a watercooled video card and motherboard chipset, and you’ll understand why these products are sometimes considered exotic.

Some people also take their aesthetic mods to the extreme by using products normally reserved for the automotive industry. Body filler (sometimes known by the brand Bondo) and molded fiberglass can be used to create custom shapes and transform a system’s look completely. You couldn’t really call it a mod per say, but use these items along with metal, wood, Plexiglas, and plastic, and you can build your own custom enclosures completely from scratch. There’s no need to modify a store-bought case when you can just build one yourself. These items have been used to create some of those wild looking designs Intel showcases at IDF (Intel Developer Forum) to demonstrate its vision of the “future.” These

Asetek manufactures and distributes high-end watercooling kits that include CPU, GPU, and chipset waterblocks like these.



Vapor-phase cooling systems, like the Asetek's Vapochill, can bring your processor down to subzero temperature levels.

computers Intel has showcased were designed to spotlight the new BTX form factor and even smaller designs that may never be brought to market. Enthusiasts have also used these items (along with countless others) to build systems you would never even think were PCs.

Q **Is modding safe?**

A Generally speaking, yes, modding is safe as long as you approach each project cautiously and follow the safety guidelines for any of the tools you'll be using to complete the mod. Just be careful and *always* wear protective gear like safety goggles and gloves, especially when cutting metal. Those freshly cut edges can be very sharp, so be careful. We'd also recommend not wearing baggy clothes, as they can easily get caught in a spinning power tool. This isn't necessarily a safety issue, but you should also be aware that anytime you make a modification to a component, you will almost certainly void its warranty. If you're not comfortable losing your warranty coverage, you probably shouldn't take that soldering iron to your motherboard or pry that heat spreader from your CPU.

There are a virtually limitless number of possibilities when modding a system. The extent of your mods is limited only by your imagination and possibly your budget. Luckily, there are a slew of online resources available if you need some inspiration, and many mods won't cost you a penny if you already have access to the necessary tools. If you'd like to rub elbows with some fellow modders and see just how far PC modding has come, we recommend visiting the forums on some of the more popular hardware Web sites. HotHardware.com, HardOCP.com, and Anandtech.com are some of my favorites. Mod-Centric sites like Bit-tech (forums.bit-tech.net) and PheatonForums (www.pheatonforums.com) are also fantastic resources. CPU

by Marco Chiappetta

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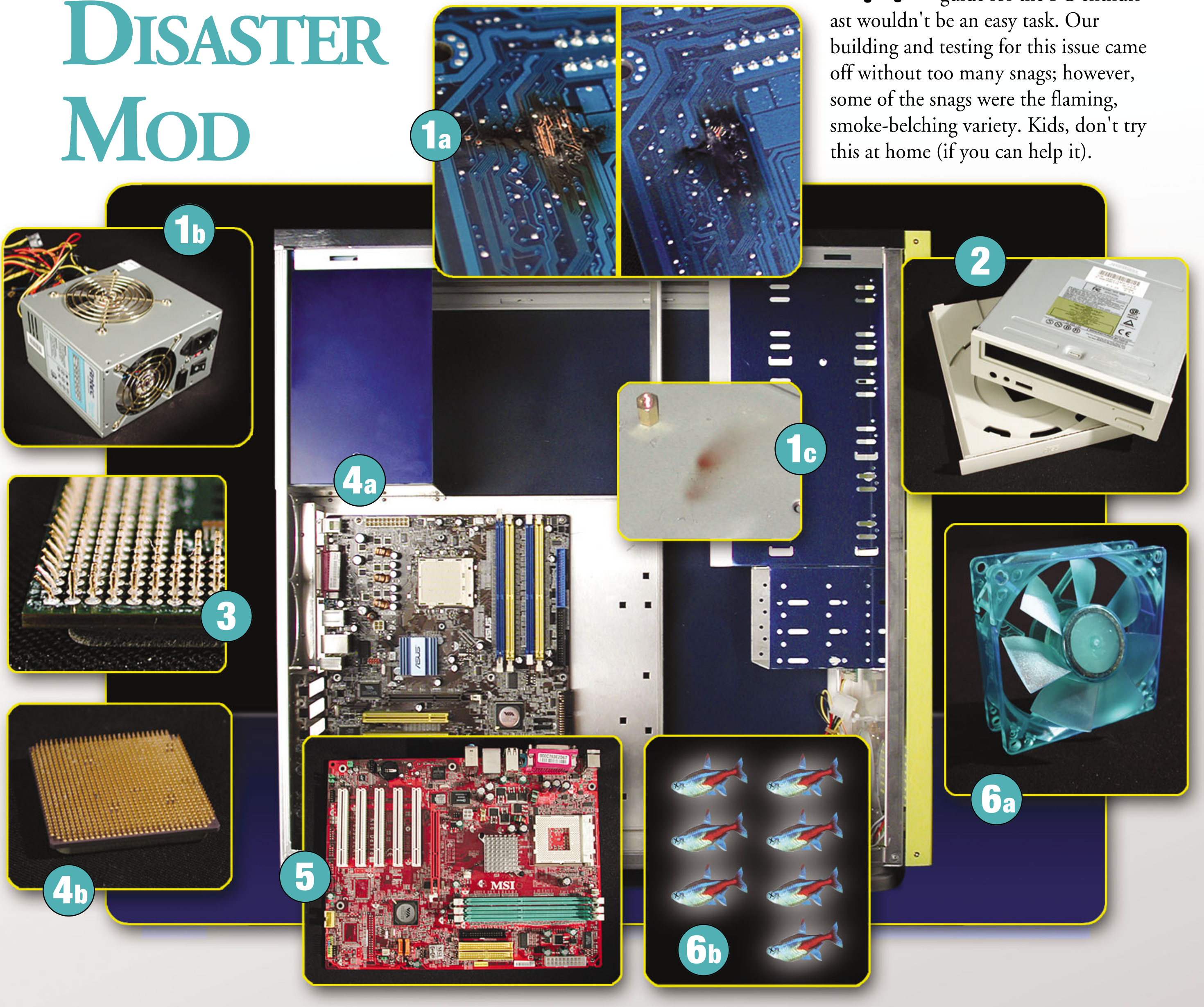
THE ULTIMATE DISASTER MOD

We at *CPU* knew that bringing you the ultimate guide for the PC enthusiast wouldn't be an easy task. Our building and testing for this issue came off without too many snags; however, some of the snags were the flaming, smoke-belching variety. Kids, don't try this at home (if you can help it).



1 While overclocking the Gigabyte GA-K8VNXP (1a), we raised the CPU voltage from 1.5 to 1.6, and then we smelled smoke from the motherboard and PSU (1b). With a fresh GA-K8VNXP and a new power supply, we tried it again and got more smoke. We shut down in time to save the PSU, but our motherboard and case were permanently scarred (1c). The moral of the story: If at first you fry your motherboard, don't try the same thing again.

2 We destroyed this optical drive when we manually pulled the tray out for a soldering procedure, which jammed gears beyond repair.

3 What do you mean the pins aren't supposed to bend like that?

4 Conformal coating is great for sealing components from moisture, but not so great for sockets (4a) and CPU pins (4b). We lost two motherboards and two CPUs from stray drops of this stuff. One of the lost CPUs was an Athlon 64 FX-53. We wept.

5 We inadvertently fried this motherboard when we powered it up without first mounting it to the standoffs inside the case. Whoops!

6 This fan (6a) was submerged in our fish tank/water reservoir in an attempt to protect our fish from the force of the incoming water. Unfortunately the plan backfired, and seven beloved neon Tetras (6b) swam to fishy heaven after rust from the fan apparently ruined the water's PH balance. We mourned.

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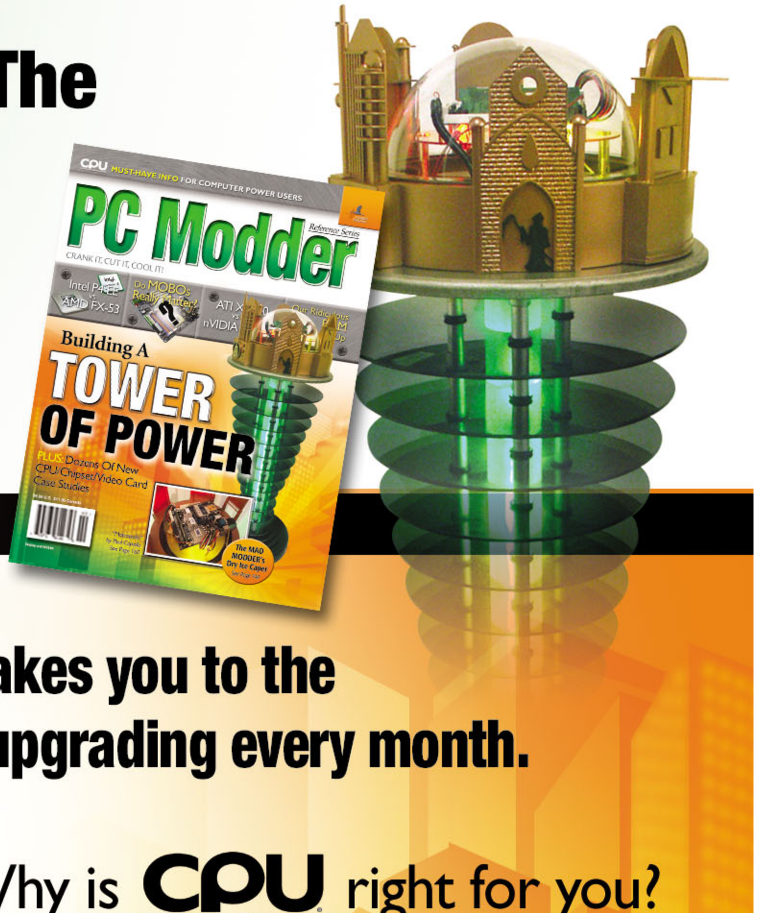

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